

Lake Winnipeg Shoreline

EROSION ADVISORY GROUP

An Independent Review
of Shoreline Erosion
along the
Shorelines of the
South Basin of
Lake Winnipeg
and Related Issues

FINAL REPORT
September, 2000





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Executive Summary

The Government of Manitoba established the Lake Winnipeg Shoreline Erosion Advisory Group (Advisory Group) in October 1998 to review specific issues related to the erosion of Lake Winnipeg shorelines. The membership of the Advisory Group includes mayors and reeves from south basin municipalities, property owners, representatives from First Nation communities and individuals with engineering expertise.

The terms of reference required the Advisory Group to gather information on erosion processes and *practical* shoreline options for dealing with erosion, verify the integrity of Manitoba Hydro's reporting of Lake Winnipeg water level data, identify and respond to public concerns and advise the Province and stakeholders on matters regarding erosion.

The work of the Advisory Group focused on the south basin. To fulfil its mandate, the Advisory Group toured erosion sites and beaches, held public meetings, received presentations from Crown corporations and government agencies, issued newsletters and commissioned studies on technical matters.

Public interest has featured prominently in this work. Public concerns initiated this review. Public representatives such as reeves and mayors and representatives from First Nation communities sit on the Advisory Group. A series of public meetings was well attended and the Advisory Group received excellent presentations.

The Advisory Group commissioned a number of technical studies including:

- a review of Lake Winnipeg water level reporting procedures, to verify the accuracy and integrity of Manitoba Hydro's water level data and methodology;
- hydrometric station elevation confirmation, to verify the benchmarks to which the water levels gauges were referenced and to confirm the accuracy of the gauge readings;
- erosion measurements at selected sites along the Lake Winnipeg shoreline over the last 40 years;
- a study of property rights and jurisdiction, and
- a study of erosion processes and recommended shoreline protection options.

The shoreline protection options will be produced in the form of a handbook for distribution to individuals, municipalities and First Nations.

This document constitutes the final report of the Lake Winnipeg Shoreline Erosion Advisory Group. It includes detailed findings of the Advisory Group and summaries of the technical studies conducted on its behalf. Also included are a set of recommendations for addressing the issue of shoreline erosion.

The principle finding is that in most instances erosion, flooding and dynamic beach changes at the shoreline are the result of naturally occurring processes. Man-made alterations to the natural lake systems may affect the extent of the erosion, flooding and dynamic beach changes, but typically to a much lesser degree than the natural processes. The erosion process is complex; there are no easy or obvious answers to erosion and no solutions that work infallibly in every location. The public is frustrated by the lack of advice available regarding construction of appropriate shoreline protection measures. The public is also of the opinion that regulation of the lake for purposes of hydroelectric production is a priority of government and that nobody is effectively representing the interest of property owners and other stakeholders. An independent engineering study commissioned by the Advisory Group concluded that Manitoba Hydro's methodology for determining wind-eliminated lake levels provides a reasonably accurate description of the mean lake level conditions.

Based on its findings and on the information gathered through the technical studies commissioned by the Advisory Group, a number of recommendations have been prepared. The most significant of these are listed below.

- The Advisory Group recommends the establishment of an ongoing advisory board that would provide a basin-wide forum to review and consider management issues related to erosion and environmental quality of the lake. This board would have representation from, and work closely with government, Manitoba Hydro, local municipalities, aboriginal communities, technical specialists, the public and local interest groups.
- It is recommended that regulations and/or legislation be enacted to control the design and placement of structures on Lake Winnipeg shorelines, that shoreline protection demonstration projects be carried out, and that there should be a long-term commitment to provide technical advisory services to municipalities and property owners.
- With respect to shoreline protection options, it is recommended that whenever possible, nonstructural solutions to erosion problems be adopted. The Shoreline Protection Handbook prepared as part of this study contains specific recommendations and guidelines for shoreline protection options for different shoreline types.

Detailed findings and recommendations appear on page 82 of this report.

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Notes: 1) All photos in this report were taken in 1999/2000 unless otherwise noted.

2) *The use of Imperial and/or metric units. While it is currently standard practice to express distances, elevations, volumes and other related measurements in metric (SI) units, Imperial units have been used in this report where it is considered to be important for the understanding of the reader. This is particularly useful in expressing Lake Winnipeg water levels and river flows.*

Appendix A: Glossary of Terms

Appendix B: Advisory Group Newsletters

Appendix C: Responses to questions raised by the Lake Winnipeg Shoreline Erosion Advisory Group by:
Baird and Associates, Manitoba Water Resources
and Manitoba Hydro.

Technical Reports:

Reports and Presentations Commissioned
by the Advisory Group

- Report 1: W.F. Baird & Associates Coastal Engineers Ltd.,
Review of Lake Winnipeg Water Level Reporting
Procedures, January 2000
- Report 2: Pollock & Wright, Land Surveyors, "Hydrometric
Station Elevation Confirmation", February 2000
- Report 3: Linnet -The Land Systems Company "Erosion
Measurements, Lake Winnipeg Shoreline",
June 2000
- Report 4: Crooks, L. Buzz and D. Farlinger, "Property Rights
and Jurisdiction along the Shores of Lake Winnipeg",
February 2000.
- Manitoba Justice, "Property Rights and Jurisdiction
along the Shores of Lake Winnipeg"
- Aikins, MacAulay & Thorvaldson, "Lake Winnipeg
Shoreline Erosion: Real Property Interests"
- Report 5: W.F. Baird & Associates Coastal Engineers Ltd, and Stantec
Consulting Ltd., "Lake Winnipeg Shoreline Erosion Study"
September 2000

Presentations:

- Dr. Kamphuis lecture notes
- Manitoba Hydro presentation
- Water Resources Branch, Manitoba Conservation
presentation

2 Foreword

As the eleventh largest freshwater lake in the world, Lake Winnipeg stands as a major feature on the North American landscape. It has a surface area of about 24,000 square kilometers and a drainage basin of some 984,000 square kilometers. The length of the lake is 430 kilometers from north to south and the maximum width is approximately 100 kilometers. The lake is divided into two relatively shallow basins. Depths do not exceed 19 meters in the north basin, or 13 meters in the south basin, although depths of as much as 90 meters occur in the narrows connecting the two basins.

The people who use and enjoy Lake Winnipeg are concerned about erosion events over the last decade. However, Lake Winnipeg has for millennia been undergoing a steady expansion. Sediment cores from the center of the south basin have revealed fossiliferous material that could only have been deposited at a pre-existing shoreline. Analysis of this material indicates that most of the south basin was dry land some 4000 years ago. The dominant factor causing southward transgression of the lakeshore is tilting of the lake bed, because of uplift in the Hudson Bay region that has resulted from the melting and breakup of the continental ice sheet about 10,000 years ago. The rise in lake levels has been punctuated by climate change, especially the shift to cooler, moister conditions some 4000 years ago. In addition, the diversion of the Saskatchewan River into the north basin 4700 years ago, the switching of the outlet of the Assiniboine River from Lake Manitoba to the Red River and the progressive merging of several sub-basins to form one large lake have all had an impact on the expansion of the lake¹.

¹ Selected text and data from "Status of Lake Winnipeg Project", in Manitoba Energy and Mines, Geological Services report of Activities, 1998.



Lake Winnipeg, 7450 years ago



Lake Winnipeg, 2350 years ago



Lake Winnipeg, today

Lake Winnipeg Regulation

Water levels in Lake Winnipeg have been officially regulated since 1976.¹ Lake Winnipeg regulation and the Churchill River Diversion were central elements in developing the hydroelectric generating capacity of the Nelson River. While the mandate of this Advisory Group does not include analysis of the impact of Lake Winnipeg regulation on erosion, regulation remains an important reality of the lake.

Manitoba Hydro explains the importance of lake level regulation in an undated report *"Lake Winnipeg Erosion and Water Levels"*.

*"When Manitoba Hydro decided to develop the hydroelectric potential of the Nelson River in 1966, the decision was based on the idea of using Lake Winnipeg as a natural reservoir. By excavating channels to increase the natural outflow capacity of the lake, and by building a control structure to regulate the outflow of the lake, adequate minimum flows are guaranteed for the utility's generating stations along the Nelson River in northern Manitoba. The level of Lake Winnipeg is regulated by Manitoba Hydro by a control structure at the Jenpeg Generating Station. While the wind-eliminated level of Lake Winnipeg is between the upper storage limit of 715 feet and the lower storage limit of 711 feet, Manitoba Hydro regulates the lake for hydroelectric purposes. In general, this means that water from spring and early summer inflows is stored for use during the fall and winter, when Manitoba's electricity needs are greatest."*²

Provincial water power is managed and controlled by the Minister of Conservation pursuant to the Water Power Act and Regulation. An interim licence was issued to Manitoba Hydro under the Water Power Act in 1970 and a supplementary interim licence was issued in 1972. When land-related issues are resolved in the vicinity of the licenced area, Manitoba Hydro proposes to apply for a final licence.³ Under the interim and supplementary interim licences, Manitoba Hydro is required to regulate Lake Winnipeg and operate control structures to maintain the wind-eliminated lake levels between 711 feet above sea level (asl) and 715 ft. asl, to operate the Jenpeg control structure so that the outflow is not less than 25,000 cubic feet per second (cfs) and to ensure that the increase or decrease in discharge does not exceed 15,000 cfs during any 24 - hour period.

When the water level is above 715 ft. asl, the structures shall be operated in such a manner as to effect the maximum discharge possible under the circumstances then prevailing until the elevation of the lake recedes to 715 ft. asl.

¹ Construction of Lake Winnipeg control structures occurred from 1972-76 and may have affected water levels during this period. These structures were completed in 1976, allowing Hydro to regulate the lake from that time.

² Manitoba Hydro, *Lake Winnipeg Erosion and Water Levels*.

³ From *Presentations by Water Resources Branch, Manitoba Conservation*.

Property Development and Erosion

Prior to the 1950's, residential and cottage development in the south basin was concentrated in a few areas where good road and rail access made development possible. On the west side of the lake, this was principally the Matlock and Winnipeg Beach areas; on the east side it was Grand Beach and Victoria Beach. Rail access in the 1920's and 30's created popular resorts that attracted large crowds throughout the summer. The rail lines are either gone or no longer used for passenger traffic, but the demand for recreation property has resulted in almost continuous development on both sides of the lake. Provincial parks, other Crown land and marshy shorelines break the pattern of development. But even in the marshes, there are now harbour-front developments that use the marshes as boat access to the lake.

Erosion of Lake Winnipeg shorelines has put some of these properties at risk. And as development has become more intensive, the impact of erosion has become increasingly widespread. These concerns have been raised at various times in the past. In particular, the "Lake Winnipeg Shoreline Handbook" dated 1977 noted that:

"With the increasing popularity of cottages along the southern shore of Lake Winnipeg a need has arisen among lake shore property owners for a basic understanding of shoreline processes that could affect their property.

Our specific area of concern is the construction of erosion protection structures. In the past people have attempted to design and construct their own erosion protection structures. Sometimes they were successful but frequently they found that after having invested considerable resources, in terms of both time and money, their structures were not performing as anticipated.

.....In some cases it may not be economically feasible to construct adequate protection structures but at least the investment of effort and capital into improperly designed structures will be discouraged."

Since the publication of this handbook, cottage development has spread along much of the south basin shoreline, and the need for solutions to erosion has become more pressing.

Introduction 3

The Government of Manitoba established the Lake Winnipeg Shoreline Erosion Advisory Group (Advisory Group) in October 1998 to review issues related to the erosion of Lake Winnipeg shorelines. This action was taken in response to the concerns raised by residents and cottagers living along the lake.

The work of the Advisory Group has focused on the south basin. During its tenure, the Group toured the south basin of Lake Winnipeg, held public meetings to hear issues and concerns related to shoreline erosion, received presentations from Crown corporations and government agencies, issued newsletters and commissioned studies on technical matters. In addition, the Group met regularly to consider and deal with the issues related to its mandate.

This document constitutes the final report of the Lake Winnipeg Shoreline Erosion Advisory Group.

Issues related to shoreline erosion, loss of beaches and marshes, and environmental degradation have been difficult to quantify. The degree of erosion has been uneven, with some important beaches only lightly impacted by recent erosion events while other areas have been significantly affected. Losses have often been very personal, and *technical investigations do not always support popular notions of either the causes or remedies for erosion. In fact, many of the causes of erosion and the matters relating to it are counter-intuitive.*

While individuals have spent significant amounts of money to prevent shoreline erosion, many of the losses described by the public are not primarily monetary and do not lend themselves to economic and financial analysis. Shoreline erosion losses are in the nature of aesthetics, character, personal history and the quality of the beaches themselves. These beaches have been available to the public for generations and are now lost or in danger of being lost.

The public has also expressed concern over the threat to the existence and productivity of the marshes bordering the lake, and in particular those at the south end. These marshes have an income element in that they provide an opportunity for wild fur trapping, but an equally important part of the loss associated with marsh degradation is seen as a loss of heritage. In addition, the public noted that the marshes are important from an ecological standpoint and their loss would have a significant impact on the broader environment of the lake.

Presentations to the Advisory Group were very moving and expressed heartfelt appreciation for Lake Winnipeg and all of its varied assets.

Shoreline erosion losses are in the nature of aesthetics, character, personal history and the quality of the beaches themselves.



The Advisory Group has addressed several important issues related to erosion. These include identifying public concerns and issues, verifying the integrity of Manitoba Hydro's system of measuring lake levels and reviewing the magnitude of erosion that has occurred over the last forty years. In

addition, the Group has researched shoreline erosion processes and identified the types of shorelines that are subject to erosion. The Advisory Group retained consultants to develop recommended shoreline protection structures for the various types of shoreline. The shoreline protection options recommended by the Group and its consultants will be produced in the form of a handbook that will be available to the public, First Nation communities and municipal governments.

The Group has not conducted any research into the environmental state of the lake or the environmental impact of existing erosion control measures.

These are outstanding issues that need to be addressed through government sponsored research.

The shoreline protection options recommended by the Advisory Group and its consultants will be available in the form of a handbook.



The Lake Winnipeg Shoreline Advisory Group 4

4.1 Membership/Affiliation

The Lake Winnipeg Shoreline Erosion Advisory Group was established as an independent body by the Manitoba Government in October, 1998. The membership is made up of elected municipal officials from rural municipalities bordering the south basin of Lake Winnipeg, representatives from First Nation communities, the Manitoba Metis Federation, Lake Winnipeg property owners, and professional engineers with expertise in hydrology and erosion.

David Farlinger, P. Eng.
Professional Engineer
Chair

Kathy Arnason
Property Owner,
Gimli

Ross Bailey
Property Owner,
Gimli

Ken Danwich
Property Owner,
R.M. of Alexander

Dr. Jay Doering, P. Eng.
University of Manitoba
Civil Engineering

Martin Eva
Property Owner,
Lester Beach

Bev Fisher, P. Eng.
Professional Engineer

Reeve Harold J. Foster
R. M. of Bifrost

Gerald Harry
Little Black River First Nation

Mayor Reid Kelner
Town of Winnipeg Beach

Johann Sigurdson
Property Owner,
Chalet Beach

Carl Smith
Brokenhead First Nation

Denise Thomas
Vice - President, Manitoba
Metis Federation, Southeast

Reeve Ken Thomas
R.M. of St. Clements

Helen Trainor
Property Owner,
Victoria Beach

The Advisory Group wishes to recognize work of Harold Westdal who served as writer and technical assistant to the Group as well as Monica Sutherland, the Group's executive assistant.

5 Terms of Reference¹

Background

Lake Winnipeg shoreline property residents with eroding shorelines have been voicing concerns regarding erosion.

Through their contact with the Department of Conservation, the Minister responsible for Manitoba Hydro, and Manitoba Hydro, it has become clear that there is a need for an independent, highly accessible Advisory Group that is focused on the erosion problem. This group will be able to provide timely responses to questions, information on erosion processes, and advice on practical options for addressing erosion problems.

It has also become clear that there were expressed concerns regarding the accuracy and integrity of water level data and methodology which will be addressed.

Purpose

A public Advisory Group would provide a forum and a facilitated process for consultation, information sharing and assisting the public in their understanding of shoreline erosion. Activities would include:

- Gathering and disseminating information on erosion processes and practical shoreline protection options;
- Assisting the Province in initiating a third party assessment of the accuracy and integrity of Manitoba Hydro's reporting of Lake Winnipeg water level data and methodology;
- Receiving and responding to concerns and questions from the public regarding erosion; and
- Advising the Province and stakeholders on matters regarding erosion.

¹ These Terms of Reference are quoted verbatim from the original document.

5.1 Scope and Reports

The Public Advisory Group will commence as soon as possible and will sit for approximately 18 months and convene at least once a month. During this period the Group will issue meeting reports that will be available to all interested parties. At the completion of its work, the Advisory Group will produce a final report that will include:

- Information on shoreline erosion processes;
- Identify and assess practical options for addressing erosion problems; and
- Results of the assessment of the accuracy and integrity of Lake Winnipeg water level data and methodology.



5.2 Reporting

The Advisory Group reports to the:

Honourable O. Lathlin, Minister of Conservation
Honourable E. Robinson, Minister of Aboriginal and Northern Affairs
Honourable G. Selinger, Minister responsible for Manitoba Hydro

For administrative purposes, the Advisory Group liaises through its Chair with a Steering Committee consisting of:

Mr. R. B. Brennan, President and
Chief Executive Officer, Manitoba Hydro,
Mr. N.B. Brandon, Deputy Minister,
Department of Conservation, and
Mr. Oliver Boulette, Deputy Minister,
Department of Aboriginal and Northern Affairs.

*... it has become clear that
there is a need for an
independent, highly
accessible Advisory Group ...*

6 Overview of Activities

6.1 Advisory Group Meetings

The Advisory Group held regular monthly meetings since its inception in the fall of 1998. The purpose of the meetings was to develop strategies and plans for meeting its mandate, to receive information from government departments and agencies, and to receive and review reports and information from parties who were commissioned by the Advisory Group to conduct technical studies.

The results of the Advisory Group's work including conclusions and recommendations are included in this report.

Meeting dates and locations were:

December 1, 1998	Manitoba Hydro, Selkirk
December 22, 1998	R.M. of St. Clements Municipal Office
January 19, 1999	R.M. of St. Clements Municipal Office
February 24, 1999	R.M. of St. Clements Municipal Office
March 17, 1999	Hotel Fort Garry - Dr. J. W. Kamphuis presentation
April 22, 1999	R.M. of St. Clements Municipal Office
May 14, 1999	R.M. of St. Clements Municipal Office
August 5, 1999	R.M. of St. Clements Municipal Office
September 16, 1999	R.M. of St. Clements Municipal Office
November 4, 1999	R.M. of St. Clements Municipal Office
December 15, 1999	Selkirk, Smitty's Restaurant Conference Room
January 6, 2000	R.M. of St. Clements Municipal Office
February 15, 2000	R.M. of St. Clements Municipal Office.
April 10, 2000	Hearing Room, Public Utilities Board of Manitoba
May 19, 2000	R.M. of St. Clements Municipal Office
July 13, 2000	Lake Winnipeg Shoreline Erosion Advisory Group Office
July 21, 2000	R.M. of St. Clements Municipal Office
August 16, 2000	R.M. of St. Clements Municipal Office

6.2 Site Investigations

The Advisory Group undertook inspection tours of the south basin of Lake Winnipeg. The purpose of the tours was to observe the impact of erosion at some of the worst impacted sites and to look at shoreline protection measures that individuals and municipalities had put in place. In addition to the site inspections undertaken by the Advisory Group as a whole, there were additional inspections made with consultants retained by the Advisory Group and inspections of specific sites at the request of property owners.

6.2.1 Advisory Group Inspections

May 19, 1999

West Side of Lake Winnipeg

Sites Visited:

- Chalet Beach
- Kings Park
- Matlock
- Camp Gillwell
- Winnipeg Beach
- Ukrainian Park
- Willow Island
- Goodmans Field
- Gimli Beach
- McElheran Road
- Loni Beach
- Camp Resselka
- Pelican Beach
- Lake Forest Estates



Sea Wall at Winnipeg Beach constructed circa 1969



Beach rubble for erosion protection



Grand Beach Provincial Park

May 26, 1999
East Side of Lake Winnipeg
Sites Visited:

- Patricia Beach
- Grand Beach
- Balsam Bay
- Hillside Beach
- Beaconia
- Victoria Beach
- Grand Marais
- Wanasing Beach
- Lester Beach
- Albert Beach
- Traverse Bay



Sandy beach at Patricia Beach

October 14, 1999
East Side of Lake Winnipeg
Sites Visited:

- Little Black River First Nation
- Tour of Little Black River and Lake Winnipeg Shoreline by boat
- Tour of Manigotagan area by boat
- Seymourville



Little Black River shoreline



Inspection of Little Black River with CBWFT-TV crew

6.2.2 Other Inspections

Fall, 1998	R. Bailey, D. Farlinger <i>West Side Lake Winnipeg</i>
November 2 & 3rd, 1999	B. Fisher, D. Farlinger, and Consultants <i>East & West Side of Lake Winnipeg</i>
November 15, 1999	M. Eva & D. Farlinger <i>Little Black River, Manigotagan</i>
March 23 & 24, 2000	H. Westdal & D. Farlinger <i>West Shore</i>
April 11, 2000	B. Fisher, D. Farlinger & Consultants <i>East & West Side of Lake Winnipeg</i>
May 8 & 9, 2000	H. Westdal & D. Farlinger <i>East Shore</i>
May 8, 2000	K. Arnason, Senator J. Johnson and Senate Committee on Fisheries and Oceans <i>Kings Park</i>
August 15, 2000	D. Farlinger, Gerald Harry, Carl Smith, Denise Thomas & Consultants <i>Little Black River First Nation, Brokenhead First Nation, Hollow Water First Nation, Manigotagan and Seymourville</i>

6.3 Public Meetings

In June 1999, public meetings were held in seven south basin communities - Gimli, Riverton, Selkirk, Victoria Beach, Scanterbury, Grand Marais and Winnipeg. The purpose of the meetings was to gather information on issues, experiences and concerns related to shoreline erosion and to give the public an opportunity to express their concerns. This report provides a summary of presentations in the format of common themes, some quotes from the presentations, and a number of questions that were posed by the Advisory Board as a result of the concerns expressed by the public. Although the mandate of the Advisory Group was clearly enunciated in advertisements for the public meetings and in the Group's newsletters, many of the concerns expressed by the public at these meetings fall outside the Group's mandate.

Shoreline erosion is an extremely high priority with Lake Winnipeg residents and they are clearly determined to find some resolution to the problem.

6.3.1 Themes Of Public Presentations

- Damage is caused by a combination of high water and high winds, particularly in the fall¹.

¹ Although most presentations were concerned about high water, the Advisory Group did receive one presentation that noted that lowering the lake would cause problems for beach front harbours.

Shoreline erosion is an extremely high priority with Lake Winnipeg residents and they are clearly determined to find some resolution to the problem.

- Water levels are different than they used to be.
 - Regulation has resulted in water levels being maintained consistently at the high end of the allowable range, thereby increasing the probability of coincidence between high water and high winds. Also, water levels reported as 714 ft. above sea level (asl) today seem to be higher than water levels reported as 714 ft. asl prior to Lake Winnipeg regulation.
- The rate of erosion and amounts of damage are increasing.
- There was no environmental assessment of one of the largest projects ever constructed in Manitoba.
- Manitoba Hydro's interim licence is the longest interim licence in history and should not be made permanent without an environmental review.
- There is a lack of advice regarding appropriate shoreline protection measures.
 - There is no entity or authority to provide advice to property owners.
 - There is uncertainty and mixed advice about solutions.
 - Government agencies refuse to provide advice.
- Ad hoc erosion protection measures cause impacts to neighboring properties including physical and visual impacts and access to shoreline.
 - There is an uncertainty about the effectiveness of shoreline protection measures.
- An uncertainty about property ownership, regulations, approvals and jurisdiction is present, including:
 - concerns about construction of private shoreline protection measures on public property,
 - concerns about shoreline protection measures restricting public access to beaches and the shoreline, and
 - concerns about the lack of any approval or regulatory agency.
- A profound feeling of loss is evident among those affected.
 - Property owners, trappers and communities are losing treasured personal and community assets. For the most part this is not about money but about the destruction of something special to themselves and the community at large.
 - The sight of "magnificent" Lake Winnipeg beaches being replaced by rip-rap is disturbing.
 - There is a failure of stewardship. In one short period of time, a resource is being destroyed that should have been available to future generations.
- High levels of frustration are widespread.
 - Frustration comes from helplessness in dealing with erosion and

- apparent lack of response, concern and interest from all levels of government and Manitoba Hydro.
- Taxes are increasing while property is washing away.
- Low-income and fixed-income people who can't afford shoreline protection can only wait and watch.
- Community safety and liability is a concern.
 - Some recently constructed shoreline protection measures are seen to pose significant public safety hazards.
 - Liability related to shoreline structures is unknown.
- Government is more concerned with Hydro's profits than the health of the lake.
 - There appears to be an alignment of interests between Manitoba Hydro and Government.
 - Government is seen to support Hydro's position and/or does not have a position of its own.

6.3.2 Questions Raised at Public Meetings

The mandate of the Advisory Group includes specific direction to "receiving and responding to concerns and questions from the public regarding erosion." Presentations at public meetings raised a number of questions related to erosion processes and responsibilities for erosion mitigation.² Some of these questions were identified to the Ministers responsible and to the Lake Winnipeg Erosion Steering Committee as questions that the Advisory Group would like to address, but are outside its mandate. Other questions raised by the public are within the mandate of the Advisory Group and have been answered directly.

Presented below is a list of the principal questions raised by the public and a description of the action taken to provide an appropriate response. References are made to technical reports where these questions have been addressed in detail by one of the studies commissioned by the Advisory Group.

Question 1.

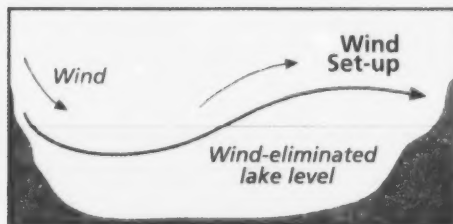
Are water levels different now, in any respect, than they were historically?

The public believes that Manitoba Hydro has maintained lake levels "artificially" high and that these high water levels, particularly in the fall, have been the principal cause of accelerated shoreline erosion. Also, many presenters, including long-time commercial fishermen claimed that lake level measurements are different today than they used to be. They maintain that levels reported under the current system are higher than prior to regulation.

In response to this general and earnest concern, the Advisory Group prepared six specific questions to address the issue of lake levels and erosion:

² In addition to questions raised by the public about erosion, the public also asked questions dealing with the environmental quality of the lake. While they are important, environmental issues are outside the mandate of the Advisory Group. To deal with environmental questions in a substantive way requires an investigation specifically tasked to this issue.

- (a) Using a common methodology, what is the long-term average level of Lake Winnipeg pre- and post-regulation? For purposes herein, pre-regulation is the time period prior to 1972 and post-regulation is after 1976. The period 1972-76 has been excluded because the levels in this period may have been influenced by the construction of infrastructure at the north end of the lake.
- (b) Using a common methodology, what is the long-term average lake level pre- and post-regulation for the fall months?
- (c) Has the method of measurement changed in the pre- and post-regulatory period and would this result in any change in the manner in which lake levels are reported? Has the type of water level reporting to the public (i.e. wind-eliminated or actual) changed in the pre- and post-regulation period?
- (d) Is the average water level at the extreme north end of the north basin different pre- and post-regulation? Has the slope of the water surface changed in the north basin as a consequence of regulation?
- (e) Would a lower lake level influence erosion? What would the effects be over time?
- (f) Does constantly maintaining the lake level at its historic average have more of a negative effect on shoreline erosion than the cumulative effect of varying lake levels in its natural range?



Wind Setup

Wind setup (or storm surge) is the increase in the height of water due to winds pushing water from one end of the lake to the other. There is a corresponding decrease in water levels, or setdown, at the up-wind end of the lake. As the result of strong and persistent winds, wind set-up of over 3.7 feet has been observed in the south basin.

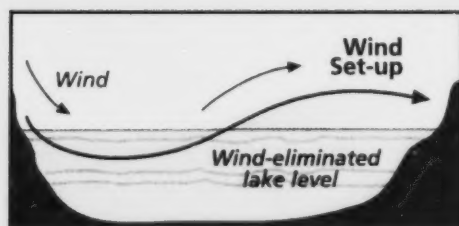
Wind-Eliminated Water Levels

The still lake water level i.e. the lake level when the effects of wind are eliminated. As stated in the section on Lake Winnipeg regulation, Manitoba Hydro is required under its operating licence to regulate the level of Lake Winnipeg between 711 and 715 ft. asl "wind-eliminated" insofar as it is reasonably possible.

These questions respecting lake levels have been addressed through the work undertaken by Baird & Associates and the Water Resources Branch of Manitoba Conservation. Questions 1(a), (b), (c) and (d) specifically are discussed in detail in Section (8) of this report.

Questions 1(e) and 1(f) are discussed briefly in the paragraphs following as well as elsewhere in the report. Manitoba Hydro has also replied to questions 1(a) and 1(f), as well as to questions 2, 3 and 4 on the pages following (see Appendix C)

- (a) Using a common methodology, what is the long-term average level of Lake Winnipeg pre- and post-regulation? For purposes herein, pre-regulation is the time period prior to 1972 and post-regulation is after 1976. The period 1972-76 has been excluded because the levels in this period may have been influenced by the construction of infrastructure at the north end of the lake.
- (b) Using a common methodology, what is the long-term average lake level pre- and post-regulation for the fall months?
- (c) Has the method of measurement changed in the pre- and post-regulatory period and would this result in any change in the manner in which lake levels are reported? Has the type of water level reporting to the public (i.e. wind-eliminated or actual) changed in the pre- and post-regulation period?
- (d) Is the average water level at the extreme north end of the north basin different pre- and post-regulation? Has the slope of the water surface changed in the north basin as a consequence of regulation?
- (e) Would a lower lake level influence erosion? What would the effects be over time?
- (f) Does constantly maintaining the lake level at its historic average have more of a negative effect on shoreline erosion than the cumulative effect of varying lake levels in its natural range?



Wind Setup

Wind setup (or storm surge) is the increase in the height of water due to winds pushing water from one end of the lake to the other. There is a corresponding decrease in water levels, or setdown, at the up-wind end of the lake. As the result of strong and persistent winds, wind set-up of over 3.7 feet has been observed in the south basin.

Wind-Eliminated Water Levels

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These questions respecting lake levels have been addressed through the work undertaken by Baird & Associates and the Water Resources Branch of Manitoba Conservation. Questions 1(a), (b), (c) and (d) specifically are discussed in detail in Section (8) of this report.

Questions 1(e) and 1(f) are discussed briefly in the paragraphs following as well as elsewhere in the report. Manitoba Hydro has also replied to questions 1(a) and 1(f), as well as to questions 2, 3 and 4 on the pages following (see Appendix C)

Generally speaking, the wind-eliminated, long-term average lake levels are approximately the same in the post-regulation period as in the pre-regulation period.

A study commissioned by the Advisory Group "Review of Lake Winnipeg Water Level Reporting Procedures" by W.F. Baird & Associates, concludes *"No significant irregularities were found in the reporting of water levels by Hydro."*

A study, "Hydrometric Station Elevation Confirmation", by Pollock and Wright, Land Surveyors which determined the elevation of the water level gauges and bench marks around the lake, concludes that, *"The gauges appear to be operating correctly relative to the bench marks ... with the exception of the Mission Point gauge and Berens River gauge."*

Note:

There is an error of approximately 0.1 m for the Berens River gauge and 0.4 m for the Mission Point gauge. The Water Survey of Canada was already aware of the problem at Mission Point and was making adjustments for it.

The question respecting the influence of lake levels on erosion, which was asked by numerous individuals, is outside the mandate of the Group and has not been investigated in any detail. However, it is understood from the work undertaken by Baird and from information presented by Dr. J. Kamphuis³, that higher lake levels would likely result in increased erosion for some finite period of time. Kamphuis suggested that the erosion rate would be increased for a few years while Baird suggested similar studies on Lake Michigan indicated that a water level increase of one foot could increase erosion by as much as 30% initially, reducing to the historic erosion rate over an extended period of time, perhaps in the order of several decades.

According to Dr. Kamphuis, a lake maintained to a relatively constant level results in less erosion than a lake with a wide range of water levels. However, the Netley Marsh Waterfowl Foundation stated that this relatively static level may have an adverse affect on the health of the Lake Winnipeg marshes.

Manitoba Hydro has stated in correspondence with the Advisory Group that water level is only one of the many factors influencing erosion. Hydro has also indicated that since it has not conducted studies to determine the relative impact of lower water levels on erosion, it cannot comment on that specific issue.

Lake Winnipeg Watch (formerly Lake Winnipeg Property Owners Association) in correspondence with the Advisory Group has indicated that it is convinced that a lower lake level would influence erosion along the shores of Lake Winnipeg. It stated that:

"Given the same wind conditions and other variables beyond the control of man, lower water levels mean lower rates of erosion while higher water levels mean higher rates of erosion - and even what might appear to be a minor increase in water level can have major ramifications over time."

³ Dr. Kamphuis is an engineering professor at Queen's University and an internationally recognized expert on coastal engineering.

Lake Winnipeg Watch goes on to say:

*"As for Manitoba Hydro's acknowledgement that it **has not** conducted studies to determine the relative impact of water levels or of alterations to the lake's natural regime, Lake Winnipeg Watch would like to point out that the very significant potential for damage to the environment and other aspects of the resource posed by aggressive regulation certainly warrants scientific study and environmental assessment."*

Question 2.

Shoreline erosion is perceived by the public to be occurring at a faster rate, particularly from 1992 to the present, during which time the public perceives regulation of the lake to be more aggressive. Is this true?

The Advisory Group prepared three related questions and forwarded them to the Water Resources Branch for reply.

- a. Has precipitation and inflows in the catchment area been greater than average since 1992?
- b. Have the summer and winter outflows from Lake Winnipeg been significantly different since 1992?
- c. Has there been an unusual (greater than average) combination of high water and winds since 1992?

Responses to these questions are summarized below:

- Water Resources Branch, Manitoba Conservation, reported that the inflow to Lake Winnipeg has been 14% above the long-term average since 1992. Summer outflows since regulation are similar to the pattern for total annual inflows while winter outflows have been above the long-term average in all but three years. This reflects the increased outflow capacity of the lake.
- For the period from 1992 to the present, summer outflows have averaged 80,000 cfs, which is about equal to the long-term average. Winter outflows have averaged 85,200 cfs, which is 34% above the long-term average.
- Average water levels for the period 1992-1999 inclusive are about 0.4 ft. above the long-term average. During this period, inflow has been about 14% higher than average. Winter outflows were 34% higher than the long-term average and summer outflows about equal to the long-term average. Both summer and winter outflows were greater than in earlier years of regulation.
- Wind setup at the south end of Lake Winnipeg occurs when a sustained northerly wind forces water from the north basin of Lake Winnipeg into the south basin. Three of the ten largest wind setup events since 1915 occurred between 1993 and 1997. The frequency of occurrence of major wind setup events doubled in the period 1992-1999 as compared to the period 1974-1991.

A detailed review of precipitation, inflows and outflows and major wind setup events is provided in Section (8) of this report.

The Advisory Group also asked whether the water surface on Lake Winnipeg previously had a slope from south to north which had been eliminated as a result of regulation. Modeling by Baird and Associates indicates that the slope on the lake from south to north is approximately 0.016 m or 0.05 ft. with most of the variation occurring in the south basin and through the narrows. Calculations carried out independently by the Water Resources Branch determined the slope to be just over .01 ft. In other words, the water surface is essentially flat, both prior to and after regulation.

With respect to erosion, the magnitude of shoreline erosion has been investigated by Linnet -The Land Systems Company, air photo interpretation specialists, and presented in their report, "Erosion Measurements, Lake Winnipeg Shoreline". A summary of their findings is presented in Section (7.2.3) of this report and their complete report is found in Technical Report 3.

Question 3.

The public has never been made aware, in any substantive manner, why Manitoba Hydro wants to maintain levels within the existing range. Hydro, on its part, has expressed concern over the prospect of any change in regulated levels of Lake Winnipeg, indicating that any reduction in the upper limit would cost Manitobans huge amounts of money. What are the details of these costs and how are they arrived at?

A summary of Manitoba Hydro's response follows. Manitoba Hydro's full response is included as Appendix (C).

"The majority of the benefit from using the one foot range between 714 and 715 feet is derived from the increased dependable energy (firm energy corresponding to the lowest flow on record). Increased dependable energy means that Manitoba Hydro will be able to delay the installation of new generating resources and/or secure higher valued long-term export sales. A secondary component of the benefit comes from increased operating flexibility. Increased operating flexibility improves the ability to manage outflows as required to meet power demands.

Hydro estimated in 1997 the total cost associated with losing the upper one foot of the range at approximately \$300 million. This estimated cost to Manitoba power consumers includes system development and operating costs as well as costs to mitigate flooding impacts on downstream communities. Since energy values have been rising over the past few years, this is more likely to be an underestimate than an overestimate."

Hydro estimates the total cost associated with losing the upper one-foot of the range is \$300 million.

Lake Winnipeg Watch (L.W.W. - formerly Lake Winnipeg Property Owners Association), takes exception to the \$300 million figure provided by Manitoba Hydro. In a letter to the Advisory Group, L.W.W. voiced its opinion.

"....., we reject the arbitrary pricetag set by Manitoba Hydro for managing the lake more moderately, with a 714 target maximum. Hydro's figure is based not only on speculation, but on a very selective frame of reference which both includes and excludes major factors at Hydro's unilateral discretion. Furthermore, Hydro does not appear to have factored into its figures the substantial revenue that would be generated from a gradual, one-time reduction in the lake level to 714 - assuming that top foot of water even exists at such time as a more moderate regime of regulation is adopted."

"Manitoba Hydro's pricetag of \$300 million for more moderate regulation is both highly subjective and questionable in light of the fact that it includes "system development" (new generating station) costs and "costs to mitigate flooding impacts on downstream communities". Since the current system more than adequately supplies Manitoba's needs and would continue to do so even if surpluses were somewhat reduced, the corporate decision to expand power production through new "system development" relates strictly to power exports rather than to the needs of Manitobans, and obviously such power sales should not be embarked on unless they justify the increased costs of building additional structures. To suggest that these costs hinge on whether or not Lake Winnipeg is regulated in a manner that is more responsive to broader environmental and economic considerations is illogical - and simply wrong."

It should be noted that the Advisory Group has not conducted an independent evaluation of the numbers indicated above. Nor has it estimated the costs, if any, to commercial fishing, tourism, fur trapping and the environment of maintaining lake levels near the top of the range.

Question 4.

Has the pattern of erosion of the Lake Winnipeg Ridge around the south end of the lake altered since 1972? If so, how? Has this changed the open water area of Netley Marsh?

The public holds the opinion that the south basin marshes have lost most of their productive capacity and are in danger of being totally lost due to flooding and erosion. The marshes were noted as being too valuable a resource to be allowed to simply fade away. Of particular concern was Netley Marsh that is now protected by a very thin beach ridge called a barrier island. A number of presenters called for the Province to carry out a comprehensive environmental assessment of the effects of regulation, particularly as it has impacted Netley Marsh.

Based on information from the Geological Survey of Canada, the historic rate of southward transgression of Lake Winnipeg is due to isostatic uplift of the earth's surface. Since the retreat of the continental ice sheet, the surface of the earth has been rebounding because of the tremendous weight that has been removed. Because the rate of uplift diminishes inland from Hudson Bay, that is, it is more pronounced to the north than to the south, a tilting action results. This tilting action has been estimated by the Geological Survey of Canada to be on the order of 20 cm per century. Over the last 4000 years this tilting action has shifted the position of the southern ridge by more than 26 km,

which translates to a long-term average lateral migration of about 6.7 m per year. However, since the movement of the ridge is episodic, long-term averages cannot be used to determine an expected migration rate in any given year. The Geological Services Branch of the Province of Manitoba estimates that over the last 350 years, the southern ridge has moved approximately 60 to 100 m. This translates to a much slower lateral migration rate of about 0.2 m per year.

The analysis undertaken by Linnet shows a very uneven pattern of erosion. Linnet found that the overall average rate of erosion over the whole of the south ridge has been 2.6 meters per year over the period 1963-1991. Rates of erosion, however, varied from a high of 46.5 meters per year in one area to accretion in other areas.

On an overall basis some 67% of the south ridge shoreline has experienced erosion greater than 0.5 meters per year while 13% has experienced accretion.

The geological model for how barrier islands work reveals that it is normal for erosion to occur on the basin side and accretion to occur on the lagoon side. This causes the barrier island to migrate landward.

Question 5.

What is the shoreline regulatory environment?

The public expressed a great deal of uncertainty about who owns the beaches and shorelines, who, if anyone, has the responsibility for their protection and who has the responsibility to approve and oversee beach/shoreline protection measures. This is an important question because shore protection structures are being built on Crown land that restrict public access to and along the beach, some structures pose safety hazards and some may cause increased erosion on adjoining properties. In many cases these structures are unsightly.

To address this question, the Advisory Group commissioned a preliminary report on "Property Rights and Jurisdiction along the Shores of Lake Winnipeg". This report identified Federal and Provincial statutes that impact on development and use of the shores of Lake Winnipeg and identified a number of questions for which answers are required. A copy of the report was forwarded to Manitoba Justice for answers to the many questions raised by the public with regard to legislation respecting property rights and the approval process. The law firm Aikins, McAulay and Thorvaldson was also asked by the Advisory Group to respond to a number of questions related to the issue. These reports are summarized in Section (7.2.4) of this report and presented in full as Technical Report 4.

Question 6.

What are the best methods of protecting beaches and shorelines from erosion?

There is a high level of frustration associated with the inability to obtain advice about shoreline protection, specifically as action is seen to be imperative, construction costs are high and results uncertain.

There is a great deal of uncertainty about who owns the beaches and shorelines, and who, if anyone, has the responsibility for their protection.

Property owners, municipalities and First Nations want technical advice on shoreline protection measures as well as financial assistance for construction. Others requested financial assistance for engineering properly designed solutions. These were central themes coming from the public meetings. The design of shoreline protection measures is also specifically identified as a major assignment in the Terms of Reference where the Advisory Group is tasked to *"identify and assess practical options for addressing erosion problems"*.

The Advisory Group commissioned a report by W. F. Baird & Associates Coastal Engineers Ltd. and Stantec Consulting Ltd. to identify shoreline protection options. This report is summarized in Section 9.2 and attached as Technical Report 5.

Question 7

Why was the previous Lake Winnipeg Management Board disbanded?

The public requested the establishment of a management board that reflects the interests of all stakeholders. The public indicated there is a need for a body that is independent of Manitoba Hydro. It was claimed that Hydro always has a statement that shifts blame and/or only presents Hydro's perspective on erosion events.

6.3.3 Quotable Quotes from Public Meetings

- *"It's all high water!"*
- *"The government failed us"*
- *"We have three recommendations. "lower the lake, lower the lake, and lower the lake"*
- *"They have sold us out to make money for Hydro"*
- *"No one will give me an answer as to who owns what land"*
- *"Our shorelines have turned into a debacle of concrete, rock and rubble"*
- *"Reckless, mercenary policies" (description of Lake Winnipeg Regulation)*
- *"The main reason for buying our property has washed away"*
- *"We have been left without any advice or support"*
- *"Shoreline armor is a horrible accident waiting to happen"*
- *"Netley Marsh has become an unstable, unnatural environment"*
- *"You can't make a decision on a Lake Winnipeg management board by consulting south basin residents only"*
- *"Hydro doesn't lie - but I'm not sure they are telling the truth"*
- *"Every fisherman knows that Hydro levels are incorrect" (commercial fisherman)*
- *"It's a question of health - yours and mine" (aboriginal elder)*
- *"The south basin is in crises"*
- *"We are hearing the voice of the lake, and its not happy"*
- *"Let us work together to identify problems and find solutions" (East side aboriginal elder)*
- *"Can't we produce electricity without destroying the land" (East side aboriginal leader)*
- *"How do I get a say when someone wants to put a groyne on the beach"*

- "Our grandchildren have never seen the beach, our great-grandchildren may never see the cottage"
- "Don't let the water get too low for boat access"
- "Every time I went for a drink I had to move my chair back"

6.3.4 Nature of Damage Identified in Public Meetings

- loss of private property
- loss of property value
- loss of recreation opportunities (beaches, sandbars and access along the beach)
- loss of tourism potential (beaches and marshes)
- aesthetics/character
- loss of income opportunities (trapping, guiding, hunting)
- cultural impacts
- environmental impacts
- community health and safety
- stress and anxiety

Magnitude of the Damage

The erosion of Lake Winnipeg shorelines is a difficult problem to put into context. It is not like other issues in Manitoba and not easily compared to other types of natural resource and personal or property impacts. It may be impossible to quantify the overall magnitude of the damage. Currently it is primarily a localized issue with direct financial costs assumed by individual property owners. While individuals have spent significant amounts of money to prevent further shoreline erosion, most of the losses described in the public meetings were not monetary and do not lend themselves to economic and financial analysis.

Shoreline erosion losses are in the nature of aesthetics and character and the loss of the beach itself. In most cases, shoreline erosion is a long-term threat to homes and cottages. In some cases, cottages have already been directly impacted by erosion.

The marshes have an income element related to trapping that can be calculated. But an equally important part of the loss was seen as related to aboriginal culture and heritage. Also, the potential loss of the ecological diversity the marshes provide was a public concern. The value of the loss of cultural, heritage and ecological factors cannot be expressed in monetary terms.

Analysis of damages is further complicated by the uneven nature of damage. While extensive shoreline has been damaged, some important beaches such as Winnipeg Beach (with shoreline protection) and Grand Beach (without shoreline protection) seem to have been only lightly impacted, if at all, by recent erosion events. Further, a small number of presenters claimed to have solved the problem with construction of their own shoreline protection measures.

Shoreline erosion losses are in the nature of aesthetics and character and the loss of the beach itself.

6.4 First Nations Concerns

There are four First Nation Communities and several Metis communities bordering the south basin of Lake Winnipeg. Representatives from two First Nation communities as well as a representative of the Manitoba Metis Federation sit on the Advisory Group as members. The Advisory Group visited three First Nation and two Metis communities.

Aboriginal groups in the area share most of the concerns expressed by the public at large. The First Nations, however, provide a somewhat unique perspective as their lands are governed under federal legislation. Treaty rights protect their right to natural resources, including fish, medicines, waterfowl and furbearers which are all potentially impacted by changes to the Lake Winnipeg water regime.

Residents of the Brokenhead Ojibway Nation have expressed concerns about flooding and associated erosion of the Lake Winnipeg shoreline. The shoreline has moved substantially inland during the lifetimes of many of the people living on the Reserve. It is currently upstream of the former confluence of Triple Creek and the Brokenhead River. Other concerns are related to the impact to the marsh which borders the Reserve and has been a traditional area for both waterfowl hunting and wild fur trapping.

In general, the First Nations indicate they have seen a significant decline in furbearing animals and a reduction in waterfowl. Trappers and their families used to trap muskrat, raccoon, beaver and mink. High water on Lake Winnipeg after freeze-up causes muskrats to drown in their houses. They point out that marshes dry up faster in the summer than they used to and that natural channels and open areas are now becoming clogged with vegetation. Brokenhead residents indicate that at times of high water, the marsh expands further into their Reserve and floods pasture areas. Representatives of Little Black River First Nation indicate that there were once extensive haylands near the mouth of the Black River. These are now gone. They also report that wild rice that grew along the river is gone, and the Lake Winnipeg shoreline is eroding inland. The First Nations attribute these problems to flooding created by high water levels.

The First Nations in the area do not feel that the erosion has been the result of natural processes, but are of the opinion that it is a result of flooding which is man-made and caused by Hydro development.

People in every First Nation community have also expressed concerns about unusual algae growth fouling commercial fishing nets. A more general concern is the overall quality of water in the rivers that flow through their communities as well as in Lake Winnipeg itself. They feel some of these concerns could be addressed by having buffer zones along inland waterways and prohibitions on draining inland bogs and swamps.

The Advisory Group also heard similar views and concerns from the Metis people when visiting communities such as Manigotagan and Seymourville.

As a result of specific concerns raised by aboriginal groups along the east side of the lake, representatives of the Advisory Group including David Farlinger, Gerald Harry, Carl Smith and Denise Thomas, and a representative of W.F. Baird & Associates Coastal Engineers visited a number of these communities on August 15, 2000. Following is a summary of what the group observed and learned from the local people. Detailed discussions are presented in Technical Report 5 by Baird and Stantec, "Lake Winnipeg Shoreline Erosion Study".

Brokenhead

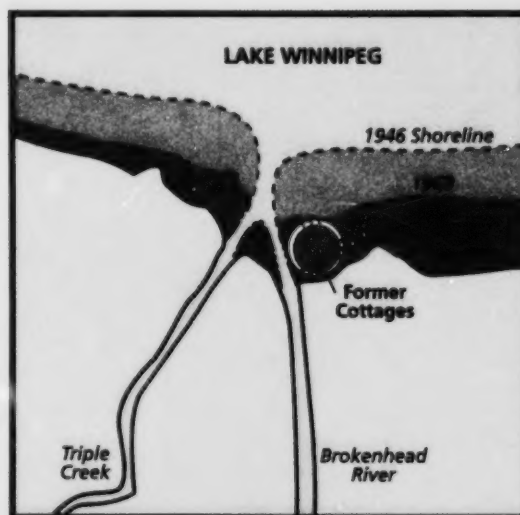
The Brokenhead River enters Lake Winnipeg on the southeast corner of the lake. The edge of the Brokenhead River is low-lying with predominant areas of marsh vegetation. From the mouth of the river to about 10 km west to Pruden Bay, the lake shore is a barrier island generally less than one meter high and ranging from 25 to 100 meters wide. The narrow or non-existent backshore and low, heavily vegetated and eroding dune ridges between Pruden Bay and Stoney Point (northeast of the river mouth), as well as submerged buildings at the mouth of the Brokenhead River, indicate that the shoreline is retreating.

Air photos from 1946 show that Triple Creek once joined the Brokenhead River from the west, just upstream of the mouth, and they emptied into the lake through a single channel. A 1974 study reported historic shoreline erosion rates of 3 to 7.3 meters per year in the vicinity of the mouth of the Brokenhead River. By 1987, the shore had eroded so far south (estimated to be in the order of 200 to 300 meters) that Triple Creek flowed directly into the lake. The foundations of cottages once along the bank of the Brokenhead, are now under water. Air photos from 1929 show hay fields in the area south of the barrier island, east of Pruden Bay. By 1996, the area had given way to marsh and open water.

The transgression of the shoreline and the effects of wind setup result in the long-term and short-term flooding of the shoreline areas.

Black River

Black River is about midway along the east side of the south basin of Lake Winnipeg. Little Black River joins Black River about 2.5 km upstream of the lake shore. The rivers' edges are low-lying with predominant areas of marsh vegetation. Bedrock outcrops occur.



Lake Winnipeg Shoreline at Brokenhead River and Triple Creek



Site of former cottages at mouth of Brokenhead River (note fireplace in water)



Flooding at former site of Black River School

According to local knowledge, the river has grown wider over time and adjacent areas have become submerged; former hay fields are now wetlands. Reportedly, houses and a school were once located along the river, but have long been abandoned due to rising water.

The shoreline in the area is relatively low and characterized by a succession of shallow bays between bedrock and boulder-lag headlands. Mixed sand and gravel beaches and erosional scarps fringe the bay shores and shallow gravelly washover veneers are present at some headland locations. Vegetation extends down across the upper beach in some places, implying a period of reduced wave runup. Vegetation also commonly extends into the water on gravel shoal platforms and headlands.

Manigotagan



Shoreline erosion at Manigotagan

The Manigotagan River enters the lake on the east side, near the north end of the south basin near Black Island.

On the north side of the mouth of the river (at Cryderman's Cove), the clay bank is actively eroding, with the bank being eight to 10 feet high. Reportedly, the erosion has been on-going for some time, and appears to be worsening. Nearby shoreline areas have marsh vegetation, and are not eroding because they were sheltered from wave action by bedrock outcrops.

Radiocarbon dating conducted in 1994 on a tree stump from the foreshore at Observation Point (south of the Manigotagan River) indicates that at least some of the recent long-term water level fluctuation may be basin-wide. This suggests that the level of Lake Winnipeg over the past few centuries may have been affected by climatic variations as well as isostatic rebound.

Hollow Water

Hollow Water is about 10 km north of Manigotagan. Bedrock and boulders appear along the shore and vegetation extends to the water's edge, indicating that erosion may not be a significant concern. Flooding due to long- and short-term water level fluctuations may be a concern along low-lying areas of the shoreline.

Summary of Presentations and Reports 7

Commissioned by the Advisory Group

7.1 Presentations

Three presentations were requested by the Advisory Group. These included a presentation by Dr. J. William Kamphuis with regard to erosion processes and a presentation from Manitoba Hydro regarding their methodology for the determination of wind-eliminated lake levels as well as historical erosion rates and water levels. Finally, a presentation was received from Water Resources Branch regarding their mandate pursuant to the Water Power Act and Regulation.

7.1.1 Dr. J. William Kamphuis, Queens University

Dr. J. William Kamphuis is a professor of engineering at Queens University, former Director of the Queens University Coastal Engineering Research Laboratory and an internationally recognized expert on coastal engineering.

At the request of the Advisory Group, he presented a lecture on March 17, 1999 concerning erosion processes and coastal protection. The presentation was not specific to Lake Winnipeg, but focused on general principles and commonly understood elements of coastal engineering. It was intended to provide Advisory Group members with an overview of erosion processes and issues related to shoreline protection. Presentation overheads are available in Technical Report 6: Presentations.

Dr. Kamphuis shared a number of observations related to his experience on the Great Lakes and other locations where erosion is an issue.

- Erosion and shoreline protection are complex issues that arise wherever human populations encroach on shorelines. Assessment of these issues should proceed with a great deal of caution - there are no easy or obvious answers, and no solutions that work infallibly in every location.
- A significant amount of erosion occurs beneath the water in the foreshore area and is hidden from view. Erosion of the foreshore is a long-term process that culminates in episodic failure of banks. If the foreshore was not eroding, then erosion processes would reach equilibrium at some point. The key to erosion is how quickly the foreshore is ground down at low water levels. High water results in sensational photographs of erosion but the groundwork for erosion occurs at low water levels. Foreshore erosion, which is rarely noticed, controls erosion of banks.

Erosion and shoreline protection are complex issues that arise whenever human populations encroach on shorelines.

- If water levels are raised by some amount (e.g. one foot) then the erosion rate increases returning to the historical rate after some period of time.
- Waves shape the beach and bluffs - not the opposite. High waves take sand from shore and low waves replace it. Sand bars are formed by waves but it is a common misconception that they dissipate wave energy. Sand bars only dissipate wave energy when waves break on them; and eventually these breaking waves will move the bars. When bars disappear, some process is moving the sand from the region and redepositing it offshore, or more likely elsewhere along the shore. Often there is not enough sand coming in to the region from other parts of the lake to replace the bar.
- Poorly designed shoreline protection structures provide little long-term benefit and often cause significant damage. Kamphuis was particularly critical of groynes. While they may provide relief in some locations, Kamphuis was of the opinion that these and other types of structures that protrude into the lake create off-shore currents which move sand into deeper waters, losing it permanently off-shore, and create significant down-drift erosion. The down-drift erosion from a single groyne has been observed to occur up to two kilometers along the shoreline starting from immediately "behind", or down-current from, the groyne.
- Any action to combat erosion should carefully consider all of the potential unintended impacts. These may include environmental impacts to fish habitat, water quality and other parameters, social impacts such as restricting access to the beach, visual impacts and community safety, and economic impacts. Shoreline structures can cause each of these impacts by physically blocking the shoreline, creating a hazard, changing offshore currents and increasing turbidity.
- Pilot demonstration projects and handbooks that outline good erosion control practices are promising courses of action that often fail. Pilot projects tend to be under-funded for the long-term assessments that are required. Handbooks are often too generalized. To save money, property owners and municipal governments under-build structures and fail to maintain them. Erosion control structures rarely look like they are depicted in the handbook and can often worsen the local erosion problem.

Poorly designed shoreline protection structures provide little long-term benefit and often cause significant damage.

- Planning and constructing a properly designed shoreline protection structure requires a large amount of data such as historic rates of erosion, ice forces and wind and wave data.
- Be wary and careful of uncertainties when employing numerical models regarding erosion.
- Unregulated development is a serious issue. Development and placement of erosion control structures should be codified.

7.1.2 Manitoba Hydro

Manitoba Hydro made a presentation to the Advisory Group on December 22, 1998. Representing Manitoba Hydro was Randy Raban, (then Manager, Hydraulic Engineering & Operations Department) and Halina Zbigniewicz (then Water Resources Section Head, Hydraulic Engineering & Operations Department).

Hydro's presentation included:

- the methodology used for determining actual and wind-eliminated water levels;
- the geological history of Lake Winnipeg;
- the history of erosion at selected sites on Lake Winnipeg;
- the erosion process as it relates to soil types, exposure, shore slope, vegetation, man-made structures, soil saturation above the water line, wind and wave energy and water levels;
- the rationale and methodology for Lake Winnipeg regulation, and
- historical lake levels on Lake Winnipeg from 1915 to the present.

Hydro's presentation materials (overheads and photos) are provided in Technical Report 6: Presentations.

7.1.3 Manitoba Conservation

Water Resources Branch, Manitoba Conservation made a presentation to the Advisory Group, February 24, 1999. Representing the Water Resources Branch was Steve Topping, Director, accompanied by Rick Bowering, Manager of Surface Water Section and Tat Lui, Planning Engineer.

The Water Resources presentation included an overview of their mandate respecting Lake Winnipeg, Lake Winnipeg regulation, public information, lake level forecasts and monitoring. Their presentation materials are provided in Technical Report 6: Presentations.

Mandate

Provincial water power is managed and controlled by the Minister of Conservation pursuant to the Water Power Act and Regulation. The Water Resources Branch administers this Act on behalf of the Minister. Responsibilities under the Act include:

- licencing water power developments;
- monitoring and enforcing licence terms and conditions;
- establishing and maintaining water power reserves; and
- controlling use of Crown Lands that have water power interests.

Lake Winnipeg Licencing

- An interim licence was issued to Manitoba Hydro under the Water Power Act in 1970 and a supplementary interim licence was issued in 1972. Once land-related issues in the vicinity of the licenced area are resolved, Manitoba Hydro proposes to apply for a final licence.

Lake Winnipeg Regulation

- Under the interim and supplementary interim licences, Manitoba Hydro is required to regulate Lake Winnipeg and operate control structures to maintain the wind-eliminated lake levels between 711 feet asl and 715 asl, operate the Jenpeg control structure so that the outflow is not less than 25,000 cfs and that the increase or decrease in discharge does not exceed 15,000 cfs during any 24-hour period. When the lake is below elevation 711 feet, the control structure at Jenpeg shall be operated as ordered by the Minister.

When the water level is above 715 ft. asl the structures shall be operated in such a manner as to effect the maximum discharge possible under the circumstances then prevailing until the elevation of the lake recedes to 715 ft. asl.

Monitoring and Compliance

- The Water Resources Branch monitors Manitoba Hydro's activities through reviews of monthly hydraulic reports and monitors lake levels through the daily retrieval of data from eight recording stations around the lake.

Public Information and Forecasts

- The Water Resources Branch issues recorded water levels every six to eight weeks.

7.2 Reports

The Lake Winnipeg Shoreline Erosion Advisory Group commissioned five technical reports to examine issues mandated by the terms of reference and raised in public meetings. These reports address the following issues:

- assessment of the accuracy and integrity of Lake Winnipeg water level data and methodology;
- hydrometric station elevation confirmation;
- assessment of erosion of the Lake Winnipeg shoreline;
- property rights and jurisdiction along the shoreline of Lake Winnipeg; and
- practical options for addressing erosion problems.

All of the reports commissioned by the Lake Winnipeg Shoreline Erosion Advisory Group are available as separate technical reports to the main report and available from the Lake Winnipeg Advisory Group.

7.2.1 W.F. Baird & Associates Coastal Engineers Ltd., Review of Lake Winnipeg Water Level Reporting Procedures

Background

Manitoba Hydro's licence to regulate Lake Winnipeg requires Hydro to maintain Lake Winnipeg at a level between 711-715 ft. asl (wind-eliminated) insofar as it is reasonably possible. Determining the wind-eliminated level of the lake is a complex task. The methodology employed by Hydro to determine the wind-eliminated level of the lake is contained in a report "Report on Lake Winnipeg Levels" prepared by the Ad Hoc Committee on Lake Winnipeg Datum.

Residents, cottage owners, fishermen and aboriginals, as well as others along the lake have complained for some time that the lake level numbers provided by Manitoba Hydro appear to be incorrect, and that lake levels are higher today than they used to be at the same stated level. For example, when Hydro states that the lake level is at 714 ft. asl, the water level is higher than when the water level was reported to be 714 ft. asl before regulation.

Until 1976 or so, the water levels generally reported to residents along Lake Winnipeg were the actual levels read at Gimli or Winnipeg Beach. Using this information, residents could compare and identify the water level with distinct features on the shoreline, or in shallow water such as a large boulder.

Initially, Water Resources Branch did ascertain wind-eliminated levels by drawing a smooth line through a plot of daily levels at Winnipeg Beach often supplemented with daily levels at Berens River. These wind-eliminated levels were also available upon request.

Manitoba Hydro's interim licence requires Hydro to maintain the lake level within the range of 711-715 ft. asl wind-eliminated. Thus, since 1976 the water level reported by Hydro is the wind-eliminated level. When Hydro now reports a level of 714 ft. asl wind-eliminated, this level could be as much as three feet or more different than the level reported as 714 ft. asl before regulation. This occurs because of wind setup and/or seiche.

Wind setup is the increase in water level caused by wind pushing water from one end of the lake to the other with a corresponding set-down or decrease in water level at the up-wind end of the lake. Seiche is the

Residents, cottage owners, fishermen and aboriginals, as well as others along the lake have complained for some time that the lake level numbers provided by Manitoba Hydro appear to be incorrect.

"sloshing" effect of a water body after a wind setup event. The water level oscillates around the lake until it settles to its undisturbed level. These oscillations of the lake level take some thirty-nine hours when the wind setup is from north to south. The wind-eliminated level is a measure of the average level of the lake rather than the actual elevation at any particular location.

This difference in measuring or reporting water levels may be the source of confusion between lake levels pre- and post-regulation. While residents are observing and dealing with actual levels associated with land-marks, Hydro is reporting wind-eliminated levels.

Manitoba Hydro employs a methodology which was developed by an "Ad Hoc Committee on Lake Winnipeg Water Levels" and published in a report dated December, 1982. The Ad Hoc Committee was formed in August, 1971 with the following terms of reference.

"To examine the problem and make a recommendation as to the method that should be adopted to establish the level of Lake Winnipeg."

In 1979, the Committee's terms of reference were expanded to include the outlet lakes as far as the Jenpeg control on the West Channel of the Nelson River and Sea River Falls on the East Channel.

The terms of reference were interpreted to mean the "still" or "wind-eliminated" level of Lake Winnipeg as referenced in Manitoba Hydro's interim operating licence. The original members of the Committee were G.H. McKay, Chair, Manitoba Water Resources, A.K. Mattick, Water Survey of Canada and P.M. Abel, Manitoba Hydro. Subsequently, Mr. McKay was replaced by R.J. Bowering of Manitoba Water Resources, and Mr. Mattick by J.H. Wedel of the Water Survey of Canada.

In keeping with its mandate, the Advisory Group requested proposals from a number of independent coastal engineering firms to carry out a third party assessment of the accuracy and integrity of Manitoba Hydro's methodology for periodically determining the wind-eliminated water level of Lake Winnipeg and reporting these levels to the public. Four proposals were received and W.F. Baird and Associates Coastal Engineers Ltd. was unanimously selected by the Advisory Group to carry out the assessment.

***The wind-eliminated level is
a measure of the average level of
the lake rather than the
actual elevation at any
particular location.***

Report Summary

Water levels on Lake Winnipeg are regulated by Manitoba Hydro. To assist in regulating the water level control systems, a representative water level is established based on the recorded water levels around the lake. This representative water level is intended to eliminate the effects of wind, and is known as the "wind-eliminated water level". A key element of the

study was a detailed evaluation of the methodology used by Manitoba Hydro to derive the wind-eliminated water level.

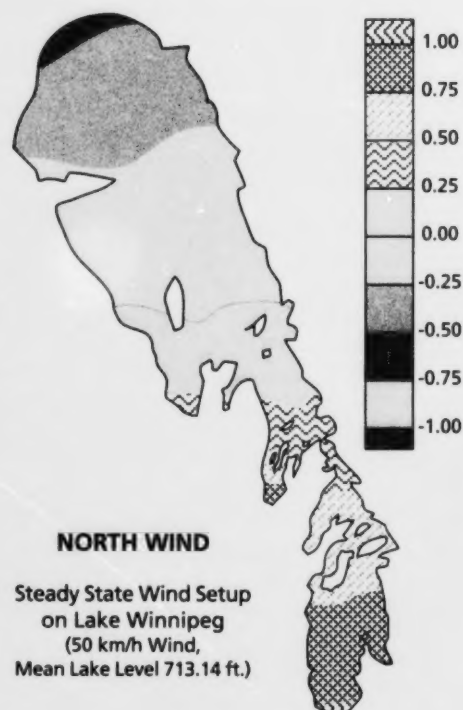
The study involved a review of technical literature which addresses water levels and gauges on Lake Winnipeg and the review and analysis of historical water level data provided by both Manitoba Hydro and the Water Survey of Canada. In order to better understand the effect of wind on the lake levels and the validity of the method used to calculate the "wind-eliminated water level", a numerical model was developed that simulated storm surge effects on the lake.

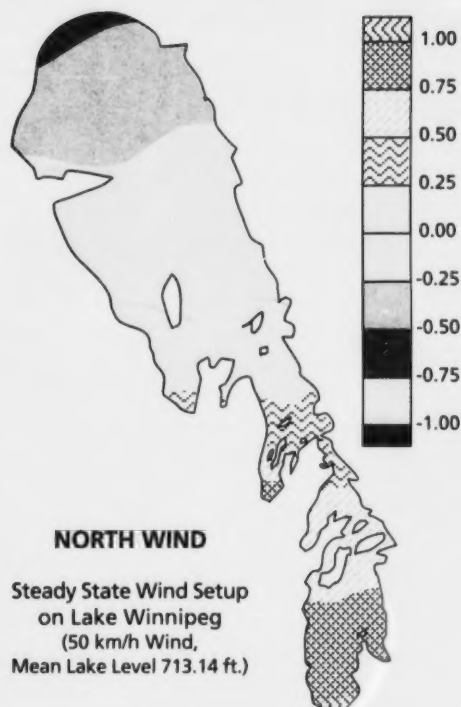
From the analyses carried out, it was determined that there are no significant irregularities in how the water level information is being determined and reported by Manitoba Hydro (Hydro).

Analyses, conducted with the numerical model, demonstrated that the method presently used by Hydro to compute the wind-eliminated water level is slightly biased towards the south basin of Lake Winnipeg because of the larger number of water level gauges per surface area of the lake in the south basin. Lake Winnipeg is susceptible to significant storm surge during wind-storm events due to its shallow water depths. When two or more storm surge events occur in succession, use of the existing methodology results in a bias of a few centimeters from the true wind-eliminated water level. It was also shown in the study that the existing procedure can only provide a wind-eliminated water level that is ten days previous. However, the amount the lake level would change over a 10-day period would be minimal even at maximum discharges from the lake, and would have little impact on lake level management. For example, for a net difference in discharge of 50,000 cfs (outflow minus inflow) a 10-day old level would only be in error in the magnitude of less than 0.05m (2 in.). It is possible to improve the current methodology to provide more up-to-date information. An example of such a method is discussed in the report.

Analysis of historical data from the various water level gauges distributed around the lake showed slight differences in the observed monthly water levels even during periods of ice cover. The largest difference was observed at the Victoria Beach station where the level appears to be about 5 cm higher than that at Berens River. Further analyses may be required at this and other stations, and a review of the station datums should be completed. (Note: this has been carried out by Pollock and Wright Land Surveyors.)

The existing water level stations are not situated in ideal locations for the computation of an average lake level. In particular, there are more stations on the east side of the lake as compared to the west, and the smaller water volume of the south basin is over-represented. However, despite the inequitable distribution of the water level stations, a sufficiently accurate wind-eliminated water level can be computed from the data provided by the existing stations, using suitable



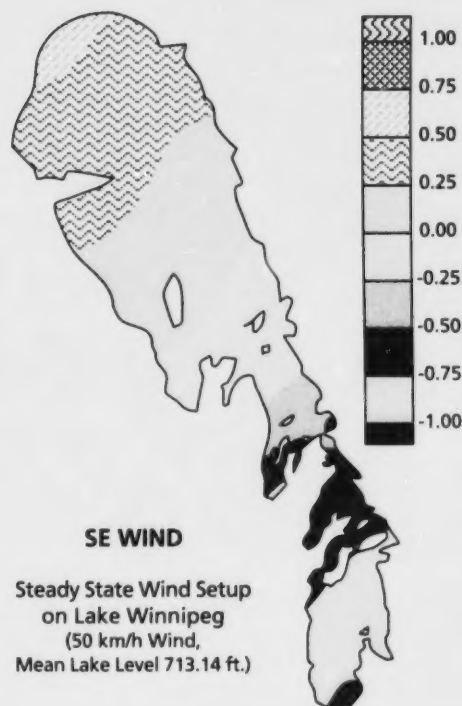


weighting factors that vary from station to station. This is currently done in the methodology used by Manitoba Hydro.

Conclusions and Recommendations

1. No significant irregularities were found in the reporting of water levels by Manitoba Hydro. Past wind-eliminated water levels are approximately representative of the amount of water in the lake.
2. It was noted when comparing monthly water level data provided by the Water Survey of Canada there were consistent differences between various stations during the months when Lake Winnipeg is covered with ice and subject to limited or no wind stress. The monthly water level at such times should provide a reasonable indication of the wind-eliminated water level in the lake. The largest difference occurred at the Victoria Beach station, which had an average water level that was approximately 5 cm higher than that measured at Berens River. It is recommended that the datum adjustments for the various water level stations be reviewed. If necessary, a water level transfer of datum be performed and verified by means of level loops to the most accessible water level stations.
3. The water level stations are not situated in ideal locations for the computation of an average lake level. In particular, there are more stations on the east side of the lake as compared to the west, and the smaller water volume of the south basin is over represented. However, despite the inequitable distribution of the water level stations, a wind-eliminated water level can be computed from the data provided by the existing stations using suitable weighting factors that vary from station to station. This is currently done in the Manitoba Hydro methodology.
4. There are limitations to the methodology used by Manitoba Hydro to compute the wind-eliminated water level on Lake Winnipeg. Specifically, the technique employed:
 - can only provide a wind-eliminated water level that is ten days old,
 - applies a weighting factor to the water levels measured at each station that is based on a statistical assessment and not on consideration of physical processes; and
 - shows a bias of a few centimeters in water level when there are two or more surge events that occur sequentially.
5. The method used to compute the wind-eliminated water level is slightly biased towards the water levels in the south basin. These short periods of bias are typically smoothed out during the averaging process.

6. Due to the considerable data-smoothing that is applied, the current methodology used by Manitoba Hydro can only compute the wind-eliminated water level that occurred ten days in the past. A more quantitative method for assessing near-present (day before) water levels on the lake could provide Hydro with a better value for making regulation decisions. This would require use of a different technique to compute wind-eliminated water levels than that which is presently employed.
7. An improved procedure for developing the station weighting factors was briefly explored in this study through use of the numerical modeling results. This initial investigation provided better estimates of the wind-eliminated water levels than the current Manitoba Hydro procedure. This technique also provided an estimate of wind-eliminated water levels for the previous day rather than ten days in the past as with the existing Hydro procedures.
8. Manitoba Hydro could better communicate the issue of Lake Winnipeg water levels to the public on their web site. Suggested changes include explanations of the water level regulation and forecasting procedures, and the presentation of data from the individual gauges. Past and predicted outflows from the lake, in addition to strategies concerning lake level regulation, would also help keep the public informed on how Hydro is operating.
9. The forecast wind-eliminated water level on Hydro's web site should have some indication of probable accuracy. Presently, two-month water level forecasts are shown to have an accuracy of ± 0.01 feet, which is clearly not realistic.



7.2.2 Pollock & Wright, Land Surveyors, "Hydrometric Station Elevation Confirmation"

Background

Proposals were requested for the confirmation of "Hydrometric Station Bench Mark Evaluation Around Lake Winnipeg." This confirmation was required to verify the water level gauges elevations, operation and readings and thus substantiate the work carried out by Baird. The project, by its nature, resulted in valuable and highly accurate survey information for future use in the region.

Several proposals were requested but only one proposal was received due to the exacting nature of the work to be conducted and the limited availability of the sophisticated equipment required along with trained operators.

The one proposal received was from Pollock and Wright Land Surveyors who are accredited to supply high accuracy Geographical Positioning System (GPS) services to the Government of Canada.

The purpose of this survey was to verify the bench marks from which the water level gauges on the lake were referenced and to confirm the accuracy of the gauge readings. One of the primary recommendations of the Ad Hoc Committee on Lake Winnipeg Datums was that it shall be assumed that the surface of Lake Winnipeg is on average flat and that water level transfer should be used to determine the gauge datums rather than land based level loops. This flat water level datum on Lake Winnipeg is referred to as Lake Winnipeg Datum (LWD). Baird recommended that the datums be verified by means of land level loops.

The Pollock and Wright survey verifies the Baird & Associates assessment.

Results and Conclusions

When adjusted, the GPS observations showed good agreement with the first order leveling network. A small bias seemed to be present when fixing to the one bench mark (86M069) at the south end of the project. This was attributed to inaccuracies in the GSD'95 geoid, bias in the GPS observations and instability of several of the bench marks. The GSD'95 geoid is a model used to correct the ellipsoidal elevations observed by GPS to mean sea level values.

The second adjustments and third adjustments of the GPS observations fixing to bench marks at the top, middle and bottom of the lake resulted in good agreement with the first order values.

From the observations carried out it can be seen that no blunders or busts (ie. significant errors) exist in the first order leveling network over the project area. The agreement between the GPS-derived heights fall well within the GPS instrument specifications and the error budget for the first order level circuits.

At each gauge location a water elevation was taken and a time of observation noted. Gauge recordings were obtained from Water Survey of Canada and Manitoba Hydro for the gauges at the time of observation. All of the bench marks established by Water Survey of Canada and Manitoba Hydro are referred to Lake Winnipeg Datum, with the exception of George's Island. The Lake Winnipeg Datum is derived under the assumption that Lake Winnipeg is flat. Observations taken by Pollock and Wright are based on the latest values for the first order leveling network and make no such assumption.

Due to the consistency in the first order leveling network, it is concluded that the current published values represent the best available elevations for the bench marks observed.

Table 7.1 shows the comparison between bench marks on the latest geodetic survey of Canada adjustment and the "Lake Winnipeg Datum". This table illustrates that each set of gauge bench marks are relatively stable

with the exception of Pine Dock, Gimli and BM5 at Victoria Beach. The published values for all bench marks are on the Lake Winnipeg Datum and do not agree with the most current values as derived from the latest adjustment of the first order level network. The differences vary from 1 to 14 cm. as shown in the table.

Table 7.2 shows the correction at each gauge for the conversion of current published elevations to the Lake Winnipeg Datum. This correction is derived by taking the difference of the current spirit leveled elevation for the master bench mark (where available) minus the same LWD elevation. In the event that the master BM is not available, a mean of the remaining bench marks will be taken and that difference used.

Table 7.3 shows gauge readings for corresponding dates and times for the water elevation along with data output from the gauges themselves.

Table 7.4 shows gauge readings for corresponding dates and times for the water elevation along with data output from the gauges themselves relative to Lake Winnipeg Datum.

The Water Survey of Canada (WSC), which is responsible for all the gauges except for Montreal Point, periodically monitors the gauges in the field and was aware that there was a problem with the gauge at Mission Point. In such cases, the WSC makes adjustments to the readings as deemed appropriate.

In a meeting with the Lake Winnipeg Shoreline Erosion Advisory Group, Pollock and Wright Land Surveyors recommended that for a more precise measurement of lake levels, gauges be placed opposite each other on the east and west shores at regular intervals along the lake.

As a result of the Baird and Associates and the Pollock and Wright reports, the Advisory Group is satisfied that the Lake Winnipeg wind-eliminated water levels determined and reported by Manitoba Hydro are reasonably accurate.

The Advisory Group recommends that the recommendations of the Baird and Pollock and Wright reports be considered for adoption, and with the cooperation of the Water Survey of Canada, Manitoba Hydro should take steps to implement these recommendations.

***The Advisory Group is satisfied
that the Lake Winnipeg wind-
eliminated water levels
determined and reported by
Manitoba Hydro are reasonably
accurate.***

**Lake Winnipeg Shoreline Advisory Group
Hydrometric Station Elevation Confirmation**

TABLE 7.1:
Comparison of existing Gauge Bench Mark Elevations (Most recent adjustment) With Published Lake Winnipeg Datum Elevations

Location/ Station	Current Elevation based on the most current adjustment of the first order leveling network	Current published Elevation based on the Lake Winnipeg "Datum"	Difference Current Current (LWD)	COMMENTS
Victoria Beach				
704-C	225.883	225.841	0.042	FIRST ORDER BM
BM4	220.092	220.044	0.048	WSC BRASS CAP
BM5	220.002	220.985	-0.983	Elevation reported unreliable
M6401	221.269	221.220	0.049	WSC BRASS CAP-MASTER
Pine Dock				
1137-C	226.295	226.281	0.014	FIRST ORDER BM
BM5	222.755	222.699	0.056	WRB SIBM
BM6	221.558	221.546	0.012	WRB BRASS CAP
M91130	219.429	219.397	0.030	WRB SIBM
Berens River				
78M079	223.132	223.159	0.027	FIRST ORDER BM
M88101	220.042	220.070	0.028	CHISELED CROSS
M91131	220.048	220.078	0.030	WRB BRASS CAP MASTER
Gimli				
68M008	220.513	220.450	0.063	FIRST ORDER BM
M83-6	218.627	218.572	0.055	NW BOLT
M89-205	219.444	219.358	0.086	WRB BRASS CAP
Matheson Island				
M91-129	219.956	219.895	0.061	SIBM
Mission Point				
M87051	219.809	219.838	-0.019	ANCHOR BOLT
M84051	219.562	219.581	-0.019	LAG BOLT
Montreal Point				
M6771	218.223	218.361	-0.138	FIRST ORDER BM
M6772	218.415	218.553	-0.138	FIRST ORDER BM
M6773	218.877	219.017	-0.140	FIRST ORDER BM
George's Island				
BM2	219.506	219.573	-0.067	WSC BRASS CAP
M87-6	219.965	220.030	-0.065	SAND ANCHOR
M87-7	218.896	218.962	-0.066	SAND ANCHOR
M99166	219.005	219.075	-0.070	STEEL ROD

**Lake Winnipeg Shoreline Advisory Group
Hydrometric Station Elevation Confirmation**

TABLE 7.2:
Corrections to Current Published elevations to LWD at each gauge location

Location/ Station	Current Elevation based on the most current adjustment of the first order leveling network	LWD elevation	Correction Current LWD	COMMENTS
Victoria Beach	225.883 (BM704-C)	225.841	0.042	Subtract from current to go to LWD
Pine Dock	221.558 (BM6)	221.546	0.012	Subtract from current to go to LWD
Berens River	220.048 (M91131)	220.078	-0.030	Subtract from current to go to LWD
Gimli	220.513(68M008)	220.450	0.063	Subtract from current to go to LWD
Matheson Island	219.956(M91-129)	219.895	0.061	Subtract from current to go to LWD
Mission Point	219.809(M87051)	219.838	-0.019	Subtract from current to go to LWD
Montreal Point	218.877(M6773)	219.017	-0.140	Subtract from current to go to LWD
George's Island	219.506(BM2)	219.616	-0.110	Subtract from current to go to LWD

**Lake Winnipeg Shoreline Advisory Group
Hydrometric Station Elevation Confirmation**

TABLE 7.3:

**Comparison of spirit leveled water elevations relative to the latest GSC vertical values and
Lake Winnipeg Datum values at each Gauge**

Location/ Station	Water Elevation based on current GSC adjustment Date/Time	Raw Observed gauge elevations LWD Dates/Times	Difference Current Current (LWD)	COMMENTS
Gimli	217.453	217.394,	0.059	Winds slight from SSE
	Nov. 23/99, 12:50	Nov. 23/99, 12:00		
		217.391, Nov. 23/99, 13:00	0.062	
Victoria Beach	217.583	217.516,	0.067	Calm Conditions
	Nov. 24/99, 13:30	Nov. 24/99, 12:47		
		217.539,	0.044	
		Nov. 24/99, 13:47		
		217.536, Nov. 24/99, 14:47	0.047	
Pine Dock	217.522	217.502,	0.020	Calm Conditions
	Nov. 26/99, 12:00	Nov. 26/99, 12:00		
Matheson Island	217.511	217.468,	0.043	Calm Conditions
	Nov. 26/99, 12:23	Nov. 26/99, 11:28		
		217.457,	0.054	
		Nov. 26/99, 12:28		
		217.457,	0.054	
		Nov. 26/99, 13:28		
Berens River	217.346	217.482,	-0.136	Iced over, Hole in Ice
	Dec. 6/99, 13:58	Dec. 6/99, 13:00		
		217.456, Dec. 6/99, 14:00	-0.110	
Mission Point	217.556	217.955,	-0.399	Light wind from SW ice in bay
	Nov. 29/99, 15:40	Nov. 29/99, 14:38		
		217.992,	-0.436	
		Nov. 29/99, 15:38		
George's Island	217.360	218.022,	-0.466	
	Dec. 7/99, 10:55	Nov. 29/99, 16:38		
		217.429,	-0.069	
		Dec. 7/99, 10:00		
Montreal Point	217.300	217.427,	-0.067	
	Dec. 21/99, 9:50	Dec. 7/99, 11:00		
		217.409,	-0.109	
		Dec. 21/99, 9:00		
		217.397,	-0.007	Iced over, Hole in ice
		Dec. 21/99, 10:00		

**Lake Winnipeg Shoreline Advisory Group
Hydrometric Station Elevation Confirmation**

TABLE 7.4:

Comparison of spirit leveled water elevations relative to LWD vertical values
and Lake Winnipeg Datum values from raw Gauge Readings

Location/ Station	Water Elevation based on LWD Date/Time	Raw Observed gauge elevations LWD Dates/Times	Difference/ Current Current (LWD)	COMMENTS
Gimli	217.390 Nov. 23/99, 12:50	217.394, Nov. 23/99, 12:00	-0.004	Winds slight from SSE
		217.391, Nov. 23/99, 13:00	-0.001	
Victoria Beach	217.540 Nov. 24/99, 13:30	217.516, Nov. 24/99, 12:47	0.024	Calm Conditions
		217.539, Nov. 24/99, 13:47	0.001	
		217.536, Nov. 24/99, 14:47	0.004	
Pine Dock	217.510 Nov. 26/99, 12:00	217.502, Nov. 26/99, 12:00	0.008	Calm Conditions
Matheson Island	217.450 Nov. 26/99, 12:23	217.468, Nov. 26/99, 11:28	-0.018	Calm Conditions
		217.457, Nov. 26/99, 12:28	-0.007	
		217.457, Nov. 26/99, 13:28	-0.007	
		217.465, Nov. 26/99, 14:48	-0.015	
Berens River	217.376 Dec. 6/99, 13:58	217.482, Dec. 6/99, 13:00	-0.106	Iced over Hole in Ice
		217.456, Dec. 6/99, 14:00	-0.080	
Mission Point	217.575 Nov. 29/99, 15:40	217.955, Nov. 29/99, 14:38	-0.380	Light wind from SW ice in bay
		217.992, Nov. 29/99, 15:38	-0.417	
		218.022, Nov. 29/99, 16:38	-0.447	
George's Island	217.470 Dec. 7/99, 10:55	217.429, Dec. 7/99, 10:00	0.041	Iced over Hole in Ice
		217.427, Dec. 7/99, 11:00	0.043	
Montreal Point	217.440 Dec.21/99, 9:50	217.409, Dec. 21/99, 9:00	0.031	Iced over Hole in Ice
		217.397, Dec. 21/99, 10:00	0.043	

7.2.3 Linnet - the Land Systems Company, "Erosion Measurements, Lake Winnipeg Shoreline"

Background

Linnet - the Land Systems Company was commissioned by the Advisory Group to undertake measurements of erosion at seven selected sites around the south basin of Lake Winnipeg. These sites represented differing shore types and except for the case of the South Ridge, coincided with the sites selected by Stantec/Baird for design of shoreline management options.

With three of the ten largest wind setup events since 1915 having occurred since 1993, concern with erosion along the shores, while historically a serious problem, has intensified.

Estimates of erosion were prepared using aerial photography extending back to 1958 and forward to the latest available photography that was suitable for this purpose. The level of accuracy that Linnet was able to achieve is such that their results should be considered as a good indication of erosion patterns but not a precise measurement of erosion at any one location. Due to different scales and quality of air photos taken at different times and the inherent distortions in air photos, the level of accuracy is in the order of 10 m over a 40-year time period. This is relatively insignificant over this many years and the Linnet results provide a good guide to erosion along the shorelines selected.

The Linnet results are not predictive in nature. They only indicate what has happened historically along the shoreline sections studied and do not necessarily provide an indication of erosion that may occur at those sites in the future. The significant amount of erosion control activities along the Lake Winnipeg shoreline may have altered the natural erosion patterns. Where there is an influence as a result of protection, it may be difficult to compare historical erosion rates with current or future rates of erosion.

There were also a number of areas where accretion to the shoreline was noted. However, some of these occurrences may, in fact, be the result of bank failure and slumping into the water, rather than the result of long-term accretion due to deposition.

Selected Sites

As discussed, Linnet was directed to estimate historical erosion at seven sites in the south basin. Six of these sites coincided with the six sites selected by Stantec/Baird for the design of shoreline options while the seventh site selected was the Lake Winnipeg Ridge at the south end of the lake. This beach ridge was selected because of concerns expressed to the Advisory Group that the ridge was disappearing.

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Methodology

Linnet evaluated dates and scales of photography as available in the provincial air photography library. The objective was to obtain photography that covered the selected area in question with the minimum number of photos so as to minimize the time required to "stitch" together photos for the area being measured.

The 1996 photo years were taken from Digital Orthorectified Imagery (DOI). This imagery has been corrected for errors of position and displacement. It has a horizontal accuracy of ± 5 meters. Because of its accuracy, photos for other years were referenced to this set. Photos from all years were scanned and pieced together to cover the whole beach area. The next step was to create a reliable baseline. The reference points that defined the baseline (e.g. road intersections) were chosen so as to be reliably visible on all years of photography. Baselines were digitized from intersection to intersection and distances to shorelines were projected at 90 degrees from the baseline out to the intersections with the shoreline. Distances from the baseline to the shoreline were measured every 100 meters, at the same location for every year of selected photography. The line of permanent vegetation was chosen as a proxy for the shoreline.

Conclusion

The general conclusion is that the Lake Winnipeg shoreline is volatile with active deposition and erosion occurring as part of the normal life cycle of the shoreline area. The methodology used provides a snapshot only, which cannot be used to extrapolate beyond the years that were measured. The overall trend in the areas that were measured is definitely toward erosion with significant erosion occurring in some locations. There is evidence that the movement is not all in one direction, but what appears as accretion on air photos may actually be the result of bank failure into the lake.

With respect to the South Ridge it is difficult to determine from the aerial photographs available if there is more or less open water in the backshore marsh now than 40 years ago. What is clear is that the area is particularly volatile and is generally moving southward or landward as would be expected with beach ridges.



Figure 7.2 - Matlock

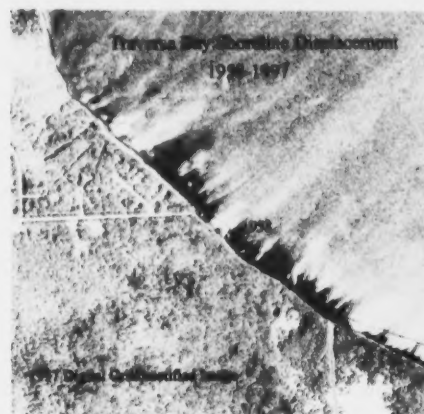


Figure 7.3 - Traverse Bay

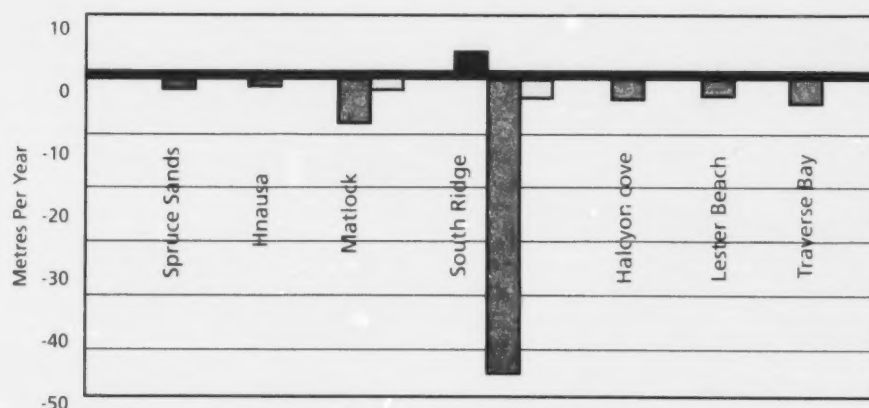


Figure 7.4 - Lake Winnipeg Annual Erosion Rates

■ Max Annual Gain ■ Max Annual Loss □ Average Annual Rate



Methodology

Linnet evaluated dates and scales of photography as available in the provincial air photography library. The objective was to obtain photography that covered the selected area in question with the minimum number of photos so as to minimize the time required to "stitch" together photos for the area being measured.

The 1996 photo years were taken from Digital Orthorectified Imagery (DOI). This imagery has been corrected for errors of position and displacement. It has a horizontal accuracy of ± 5 meters. Because of its accuracy, photos for other years were referenced to this set. Photos from all years were scanned and pieced together to cover the whole beach area. The next step was to create a reliable baseline. The reference points that defined the baseline (e.g. road intersections) were chosen so as to be reliably visible on all years of photography. Baselines were digitized from intersection to intersection and distances to shorelines were projected at 90 degrees from the baseline out to the intersections with the shoreline. Distances from the baseline to the shoreline were measured every 100 meters, at the same location for every year of selected photography. The line of permanent vegetation was chosen as a proxy for the shoreline.

Conclusion

The general conclusion is that the Lake Winnipeg shoreline is volatile with active deposition and erosion occurring as part of the normal life cycle of the shoreline area. The methodology used provides a snapshot only, which cannot be used to extrapolate beyond the years that were measured. The overall trend in the areas that were measured is definitely toward erosion with significant erosion occurring in some locations. There is evidence that the movement is not all in one direction, but what appears as accretion on air photos may actually be the result of bank failure into the lake.

With respect to the South Ridge it is difficult to determine from the aerial photographs available if there is more or less open water in the backshore marsh now than 40 years ago. What is clear is that the area is particularly volatile and is generally moving southward or landward as would be expected with beach ridges.



Figure 7.2 - Matlock

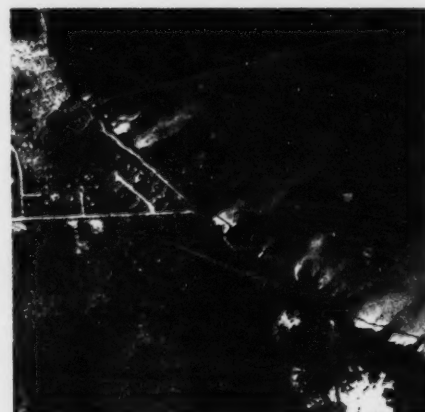


Figure 7.3 - Traverse Bay

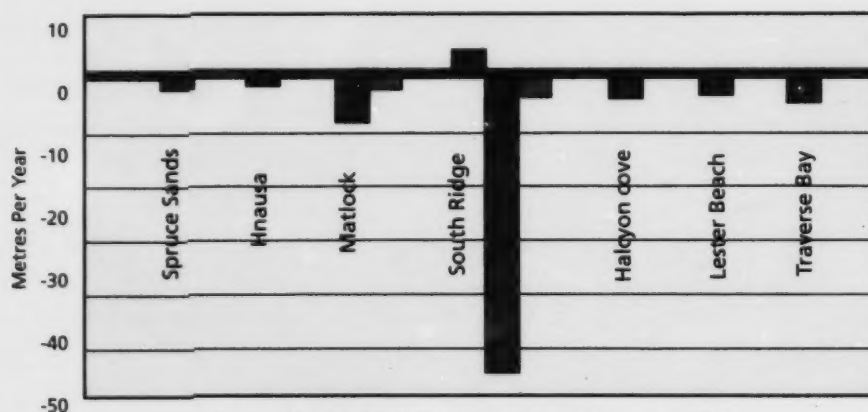


Figure 7.4 - Lake Winnipeg Annual Erosion Rates

■ Max Annual Gain ■ Max Annual Loss ■ Average Annual Rate

7.2.4 Crooks, L. Buzz and D. Farlinger, "Property Rights and Jurisdiction along the Shores of Lake Winnipeg"

The issue of land ownership and jurisdiction along the shoreline of Lake Winnipeg is a complicated question, made more complex by the number of players involved and changing conditions over time. In preparing this report, a review was undertaken of more than a dozen Federal and Provincial statutes and their Regulations in force that may impact development and land use along the shores of Lake Winnipeg. A number of individuals responsible for administering these statutes were interviewed.

Generally, responsibility for the wise management of the shoreline seems to lie with a combination of private landowners, municipal governments and the Province. The role of each will depend on the specific circumstances of the land in question, and will depend largely on how the land was originally granted and on what caveats or conditions may have been placed on the titles over time.

Prior to the Manitoba Natural Resources Transfer Act of 1930, land granted to an individual under the Dominion Lands Act may have been described as including land "to the water's edge" or to "the ordinary high water mark" with no reservations. It is also possible that the property's boundaries may have actually extended into the water. Whatever the method of describing the property's boundaries, the entitlement remains with the property and cannot be revoked.

Under these circumstances, it may be possible the land owner has the right to erect structures on the property without permission from an outside authority.

With the enactment of the Manitoba Natural Resources Transfer Act in 1930, the Province assumed "ownership" from the Federal Government of any land not already granted, both above and below the ordinary high water mark (OHWM). Generally speaking, since that date, the Province has reserved rights and interests under the Crown Lands Act on every piece of property granted or otherwise disposed. Crown reservations generally include a strip of land one and one-half chains wide (99 feet) inland from the OHWM as well as the bed of the water body. Rights and interests such as public access, boat landing and mooring, mines and minerals exploration, water power development and water level management are also reserved.

Crown reservations generally include a strip of land one and one-half chains wide (99 feet) inland from the OHWM as well as the bed of the water body.

Any works installed within the Crown reserve must be permitted by the Lands Branch, Manitoba Conservation. In practice, most works are constructed without a permit. In issuing a permit, the Province absolves itself of all liability for the structure. Permitted works are generally not inspected by the Branch during or following construction.

The Canadian Coast Guard has the responsibility for ensuring that navigation along a navigable water is not placed at risk through the installation of hazards. Any plans to install a work below the ordinary high water mark is required to be reviewed by the Coast Guard. If the proposed work is deemed to present no hazard to navigation, a "declaration of exemption" may be issued and the Coast Guard has no further interest. Works that may fall into this category include boathouses, personal boat docks and erosion control works.

Nearly all of the shoreline around the south basin of Lake Winnipeg lies within one of three Planning Districts established under the Provincial Government's Planning Act. In regards to lake shore development, the planning district places certain restrictions on development, and is concerned in particular with subdivision development. Among these restrictions is the establishment of a public reserve (different from a Crown reserve) in association with subdivision development along the lake front. The public reserve may begin at the OHWM, or it may extend into the lake, depending on the description on the original title. The width of the public reserve may be determined by establishing a certain minimum set-back from the lake, and then adding the amount of erosion that may be expected over a 50-year period. Or it may be identified simply as the 50-year erosion amount. The 100-year flood level may also be taken into consideration.

Normally, if a Crown reserve existed before the subdivision, it would be "turned over" to the planning district to be included as part of a public reserve. The public reserve as designated under the Planning Act is registered in the name of the member municipality(ties) who may establish by-laws for the management of the public reserve. According to the Planning Act, a public reserve is only to be used for recreation, parks, other public uses and public works.

Apparently, works and structures in place before the approval of a planning district plan are not affected by the plan, or by any planning by-laws established under the plan. Planning districts can make general planning statements about the use of shoreland in the district, and some have placed development recommendations on the shoreline based on the restrictions inherent under the Lands Act and the Lake Winnipeg Water Power Storage Reserve.

The Water Resources Branch reviews subdivisions, development plans and zoning by-laws on private lands at the request of Manitoba Intergovernmental Affairs or the local planning district. In regard to hazard lands which include lands below elevation 722 ft. above sea level (asl) and lands that are subject to erosion, bank instability or subsidence, the Branch generally recommends that development not be allowed unless the hazard is eliminated or protected against. The Water Resources Branch does not have the legislative authority to approve erosion protection works.

The public reserve as designated under the Planning Act is registered in the name of the member municipality(ties) who may establish by-laws for the management of the public reserve.

7.2.5 Manitoba Justice, "Property Rights and Jurisdiction along the Shores of Lake Winnipeg"

The Advisory Group, in a series of specific questions, requested Manitoba Justice to examine a number of issues relating to property rights and jurisdiction along the Lake Winnipeg shoreline. Their complete response, forwarded to the Advisory Group through the Water Resources Branch, is included as part of Technical Report 4. Following is a summary of that report. The questions, and subsequent replies, relate to four main areas of concern: land use (including installation of works), Crown reserve, public access and liability.

Land Use

There are various approvals/licences required when constructing works depending on the location, type and impact of the works. Depending on the nature of the project, a permit or licence, or a combination, may be required under the provincial Crown Lands Act, Water Power Act or Environment Act. Approval may be required from the Canadian Coast Guard under The Navigable Water Protection Act. A development permit may be required under municipal zoning by-laws.

The use or occupation of, or the construction of works on, Crown land (including a Crown reserve) without authorization is unlawful, and may be subject to enforcement action. Under The Planning Act, municipalities may enact by-laws, but these do not affect any land, building or structure lawfully in existence before the by-law.

Crown Reserve

Effective March 6, 1934, a strip of land one and one-half chains (99 feet) wide, measured inland from the ordinary high water mark was reserved by the Crown on any land granted or otherwise disposed of. For land granted before that date, the original title would have to be examined to determine whether a similar reserve was part of the grant.

The effect of erosion or accretion on the boundaries of specific parcels of land is a very complex issue. But, based on the common laws of accretion and erosion, where there is land reserved to the Crown (in effect, the Crown owns the land), erosion of the shoreline will decrease the size of the Crown reserve. Conceivably, if the erosion on the shoreline is sufficient, the entire Crown reserve could be under water. Conversely, any accretion on the Crown reserve would become Crown property.

However, in cases where a Crown reserve does not exist, it becomes very important whether the original grant of land extends to the "water's edge". If the original grant was described as being to the water's edge, it seems that the owner is entitled to any land gained through accretion. In this case, it would also seem that the owner would suffer a loss of property if erosion was to occur.

Public Access

Anyone who occupies a lot adjacent to a Crown reserve by way of lease or permit has no special entitlement to the Crown reserve in front of his or her lot. However, as a practice or policy but not as a legal entitlement, the

Crown has traditionally provided a right to the lot holder to use the Crown reserve in front of the lot. The Crown does not ordinarily encourage public use of such lands, but in some cases it may be appropriate to do so. On the other hand, the Crown may erect signs or fences indicating that the area(s) are not open to public use.

But, the public right of landing from, and mooring, boats and vessels so far as is reasonably necessary is always reserved.

Liability

The issue of liability related to impacts or injuries related to the installation of permitted or non-permitted works is complex. But in general, a person constructing or maintaining works would ordinarily be subject to liability for losses or damage resulting from the works. The Province has protected itself from liability through releases and indemnities that are ordinarily contained as conditions of work permits or land use permits.

7.2.6 Aikins, MacAulay & Thorvaldson, "Lake Winnipeg Shoreline Erosion: Real Property Interests"

The Advisory Group requested the law firm of Aikins, MacAulay & Thorvaldson to examine a number of questions concerning the jurisdiction and property rights along the shores of Lake Winnipeg. These questions centered around the issues of the Crown reserve, riparian rights and accretion and erosion, and discussed the issues using hypothetical examples of possible situations. The entire report appears in Technical Report 4. A summary of their findings is describe below.

Since 1934, the Crown (Provincial Government) has reserved from each grant of land bordering on Lake Winnipeg, a strip of land 99 feet wide, measured from the ordinary high water mark. Prior to that date, the grant may or may not have reserved land to the Crown. This can only be determined by examining the original grant.

Riparian ownership is also very important to the interpretation of the questions posed. The riparian owner is the one whose land is in contact with the water. Title to property extending to the high water mark is sufficient to entitle the owner to riparian rights.

Generally speaking, when it comes to accretion (the addition of land through natural deposition) or erosion, it is the riparian owner that wins or loses.

Question 1:

How does the long-term inland migration of the shoreline affect the location/size of the Crown reserve? Does the Crown reserve move inland in conjunction with the high water mark?

The landward boundary of the Crown reserve (that which borders the grantee's property) does not move, even when the high water mark migrates inland, unless specifically stated otherwise on the original

grant. In the situation where erosion or accretion occurs, the Crown is considered to be the riparian owner, and the reserve will shrink or expand accordingly. It is possible for the Crown reserve to erode away entirely, leaving the adjacent landowner the new riparian owner.

Question 2:

When the shore erodes, does the property line move? Does the registered owner, in effect, lose land?

Some property lines will move due to erosion or accretion depending on the surveyed plan. Where there is no Crown reserve, or if the plan does not state how deep the lot is, the registered property owner will lose land due to erosion. His lot will become smaller. Again, if there is a Crown reserve but that reserve is completely lost due to erosion, the adjacent property owner becomes the riparian owner and will be subject to land loss due to erosion.

But if a plan does state the depth of the lot, and there is no Crown reserve, the property owner whose land has been lost to the lake will continue to be the owner. However, since the land under the water is now subject to the Navigable Waters Protection Act, he/she will not be able to reclaim it.

Question 3:

Can an individual own a portion of the lake bed? For example, if the original survey monuments marking the boundaries of the property are now in the lake because of erosion, does he still own the land described by those original markers?

Generally the Crown owns the lake bed. But, it is possible under certain circumstances for an individual to own a portion of the lake bed, as noted in Question 2. However, as in Question 2, while the riparian owner may be entitled to the submerged land, the Navigable Waters Protection Act will not allow him to do anything with it.

Question 4:

And conversely, if land has been added to a property because of natural accretion (deposition along the shore), who owns the new land?

The riparian owner gains the new land. However, in some cases a private individual may have to apply to the Crown in order to have the new land vested in him. If there is an existing Crown reserve, the land will become vested in the Crown.

Question 5:

Under what conditions is the lakeshore (beach) accessible to the public? Under what conditions is it not?

From the water, there is a public right of landing from boats and other water craft as far as landing is reasonably necessary. What constitutes "reasonably necessary" is uncertain. As for access from land, it appears by The Crown Lands Act (Manitoba), that the public has the right to use any roads or trails that were in existence at the time of the original grant of land. In addition the Minister of Conservation may issue

8 Comparisons of Lake Levels:

Pre and Post Regulation

Residents have expressed a concern that lake levels post-regulation have been higher than the long-term average, particularly in the fall months when the large storms occur, thus causing greater erosion. The purpose of Lake Winnipeg Regulation is to permit the storage of water over the summer and fall months for the production of electricity during the winter months.

To respond to this concern, Baird and Associates Coastal Engineers, Ltd. was asked the following questions:

1a) Using a common methodology, what is the long-term average level of Lake Winnipeg pre- and post-regulation? For purposes herein, pre-regulation is pre - 1972 and post-regulation is post - 1976. The period 1972-76 has been excluded because the levels in this period may have been influenced by the construction of infrastructure at the north end of the lake.

According to Baird & Associates the long-term average water level at Berens River, as derived from monthly water level data provided by the Water Survey of Canada, is 713.22 ft. Lake Winnipeg Datum (LWD) from 1914 to 1971, inclusive, and 713.27 ft. LWD from 1977 to 1995. A monthly average water level at Berens River would be indicative of a wind-eliminated monthly water level on Lake Winnipeg.

For comparative purposes, the long-term average level on Lake Winnipeg, as derived from the wind-eliminated water level data provided by Manitoba Hydro, is 713.23 ft. LWD from 1914 to 1971, inclusive, and 713.31 ft. LWD from 1977 to 1995.

Baird noted that the merits of excluding any or all of the time period from 1972 to 1976 from the water level averages, due to the possible influence of the construction of infrastructure, depends largely on the details of the construction process. The nature and schedule of construction activities would have to be reviewed in context of the impact of these activities on the lake water levels. The Advisory Group notes that in the period 1971-1976, Lake Winnipeg experienced inflows 22% higher than the long-term average. Thus, it may be anticipated that water levels for that period would be somewhat higher than average.

Baird also noted that comparisons of average water levels from the pre- and post-regulation periods on Lake Winnipeg should be carefully inter-

puted. There are 58+ years of water level data prior to regulation (1971) and 19 years of data from 1977 to 1995. Rainfall over the Lake Winnipeg catchment area varies with long-term (decadal and longer) climatic cycles. As shown in Table 3.1 of the Baird report, the average water level over any twenty - year period during the pre-regulation period can vary in the order of two feet.

Table 8.1 - Long-Term Average Annual Water Levels,
(Derived from information from Baird and Associates and Manitoba Hydro)

Years	As Calculated By		
	Baird	and	Manitoba Hydro
1914 - 1971	713.22		713.23
1977 - 1995	713.27		713.31
1977 - 1999			713.40

Note: The Baird numbers in Table 8.1 are based on the long-term average water level at Berens River as derived from monthly water level data provided by the Water Survey of Canada while the Manitoba Hydro numbers are derived from wind-eliminated water level calculations. Baird indicates in their response that a monthly average water level at Berens River would be indicative of a wind-eliminated monthly water level on Lake Winnipeg.

The Stantec/Baird report states that the long-term average levels for the periods before and after regulation are very similar with both being about 713.5 ft. asl. The actual values vary depending on the time period of comparison as shown in Table 8.2

Table 8.2 - Long-Term Average Annual Water Levels
(Berens River Station, Water Survey of Canada Data)
(Source: Baird and Associates)

Averaging Period	Average Lake Level (ft)
1917 - 1936	712.74
1937 - 1956	713.18
1957 - 1976	714.61
1917 - 1976	713.51
1977 - 1995	713.27



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1917 - 1976	713.51
1977 - 1995	713.27

The average monthly water levels on Lake Winnipeg before and after regulation are shown in the following Figure 8.1.

Figure 8.1 - Average Monthly Water Levels on Lake Winnipeg Before and After Regulation

(Source: Baird and Associates)

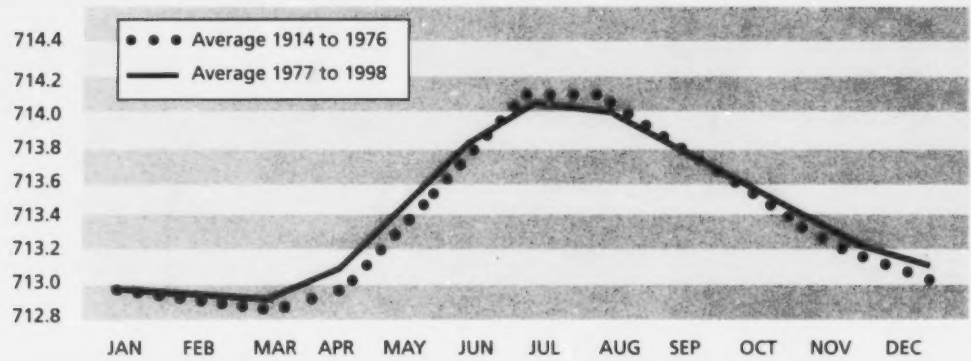
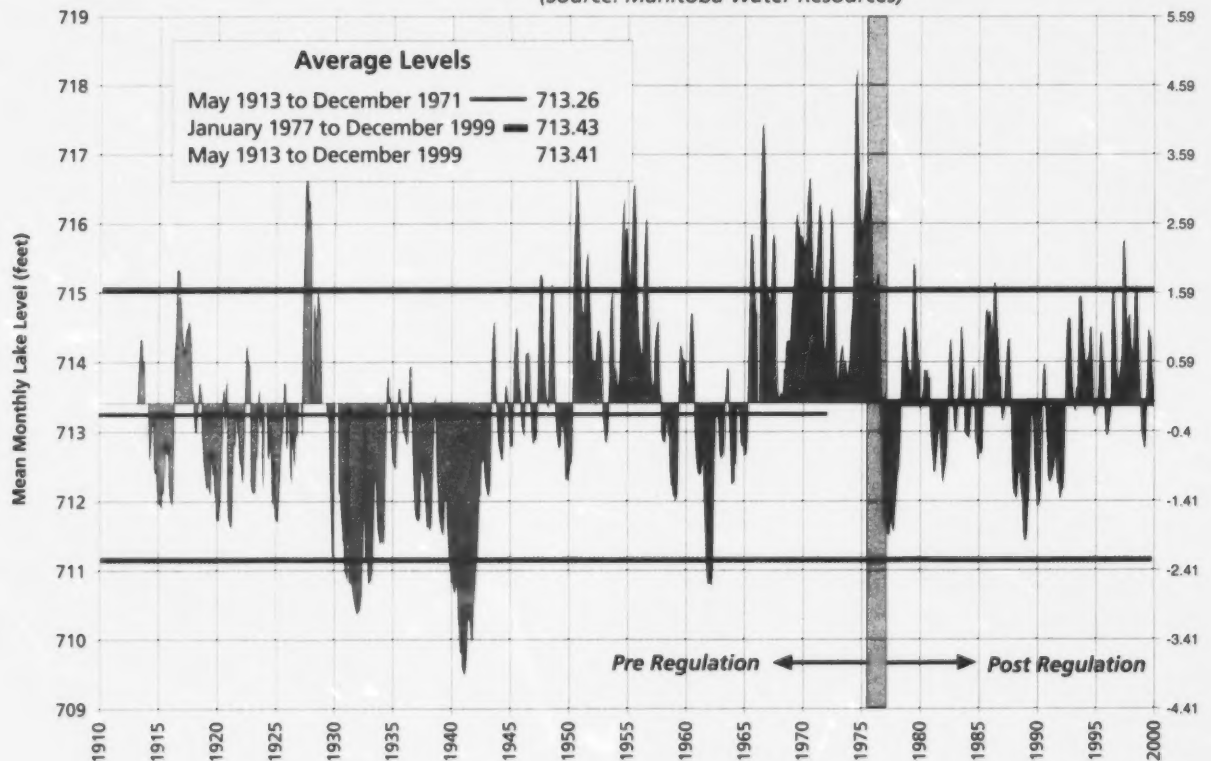


Figure 8.2 below displays Mean Monthly levels on Lake Winnipeg from 1910 to the present as recorded by Manitoba Water Resources.

Figure 8.2 - Lake Winnipeg Mean Monthly Levels

(Source: Manitoba Water Resources)



Based on Winnipeg Beach (May 1913 to September 1966) and Gimli (October 1966 to present)

1b) Using a common methodology, what is the long-term average level pre- and post-regulation (excluding 1972-1976) for the fall months? Fall is defined as the months of September, October and November.

Calculations by Baird show that the long-term average water level for the fall months at Berens River, as derived from monthly water level data provided by the Water Survey of Canada, is 713.37 ft. Lake Winnipeg Datum (LWD) from 1914 to 1971, inclusive, and 713.43 ft. LWD from 1977 to 1995. Manitoba Hydro figures are slightly higher, at 713.50 for both time periods.

**Table 8.3 - Long-Term Average Water Levels
Fall Months (Sept., Oct., Nov.)**

(Derived from information from Baird and Associates and Manitoba Hydro)

Years	As calculated by	
	Baird	and Manitoba Hydro
1914 - 1971	713.37	713.50
1977 - 1995	713.43	
1977 - 1999		713.50

Note: The Baird numbers in Table 8.3 are based on the long-term average water level at Berens River as derived from monthly water level data provided by the Water Survey of Canada while the Manitoba Hydro numbers are derived from wind-eliminated water level calculations. Baird indicates in their response that a monthly average water level at Berens River would be indicative of a wind-eliminated monthly water level on Lake Winnipeg.

The Advisory Group notes that the post-regulation lake levels both annual and for the fall months are approximately the same as the pre-regulation figures.

Baird was also asked to respond to the following question:

1c) Has the method of measurement changed in the pre- and post-regulatory period, and would this result in any change in the reported lake levels? Has the type of water level reporting to the public (i.e. wind-eliminated to actual) changed in the pre- and post-regulation period?

Following is their response:

"There have been various changes to the water level measurement methodology over the 85+ years of water level measurement on Lake Winnipeg. Most of the measurements up until approximately 1958 were based on manual measurements of water level carried out once per day. Since



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Following is their response:

"There have been various changes to the water level measurement methodology over the 85+ years of water level measurement on Lake Winnipeg. Most of the measurements up until approximately 1958 were based on manual measurements of water level carried out once per day. Since

then, self-recording gauges have been installed, providing near-continuous measurements of water level during the operation periods.

The type of water level reported to the public has changed in the pre- and post-regulation period as the present methodology for mathematical derivation of the wind-eliminated water level was not adopted until the release of the December 1982 Report on Lake Winnipeg Levels prepared by the Ad Hoc Committee. It is our understanding that prior to 1982, the wind-eliminated water levels were estimated from water level recordings taken during calm periods on the lake."

Baird was also requested to respond to the following question:

1d) Is the average water level at the extreme north end of the north basin different pre- and post-regulation (excluding 1972 to 1976)? Has the slope of the water surface changed in the north basin as a consequence of regulation?

Some residents were concerned that if regulation had removed the slope on the lake by filling the north end to a higher level that more water would be present during wind setup events thus causing greater setup of the lake.

Baird responded as follows:

"The most northerly gauge, Montreal Point, has only been operational since 1969 so there is very little data in the pre-regulation period. The next most northerly gauge, Mission Point, has operated since 1953. The average water level at Mission Point from 1953 to 1971 was 714.65 ft. LWD while the present water level over the post-regulation period from 1977 to 1995 was 713.26 ft. LWD. The 1950's to the 1970's was a period of relatively high water levels on Lake Winnipeg.

The water surface in the north basin has a near-negligible slope. This was shown in one of the hydraulic model simulations carried out for the water level study in which the water level at Montreal Point was held fixed and all of the inflows to Lake Winnipeg permitted to discharge at their mean June flow rates. This model simulation showed a total water level variation over the length of Lake Winnipeg of 0.016 m (0.05 feet). Most of the variation occurred in the south basin and through the Narrows."

Water Resources Branch calculates the slope on the lake from the mouth of the Red River to the outlet at the north end of the lake to be in the order of 0.01 feet.

The Advisory Group concludes that the water surface of Lake Winnipeg pre-regulation was essentially flat and remains flat post-regulation.

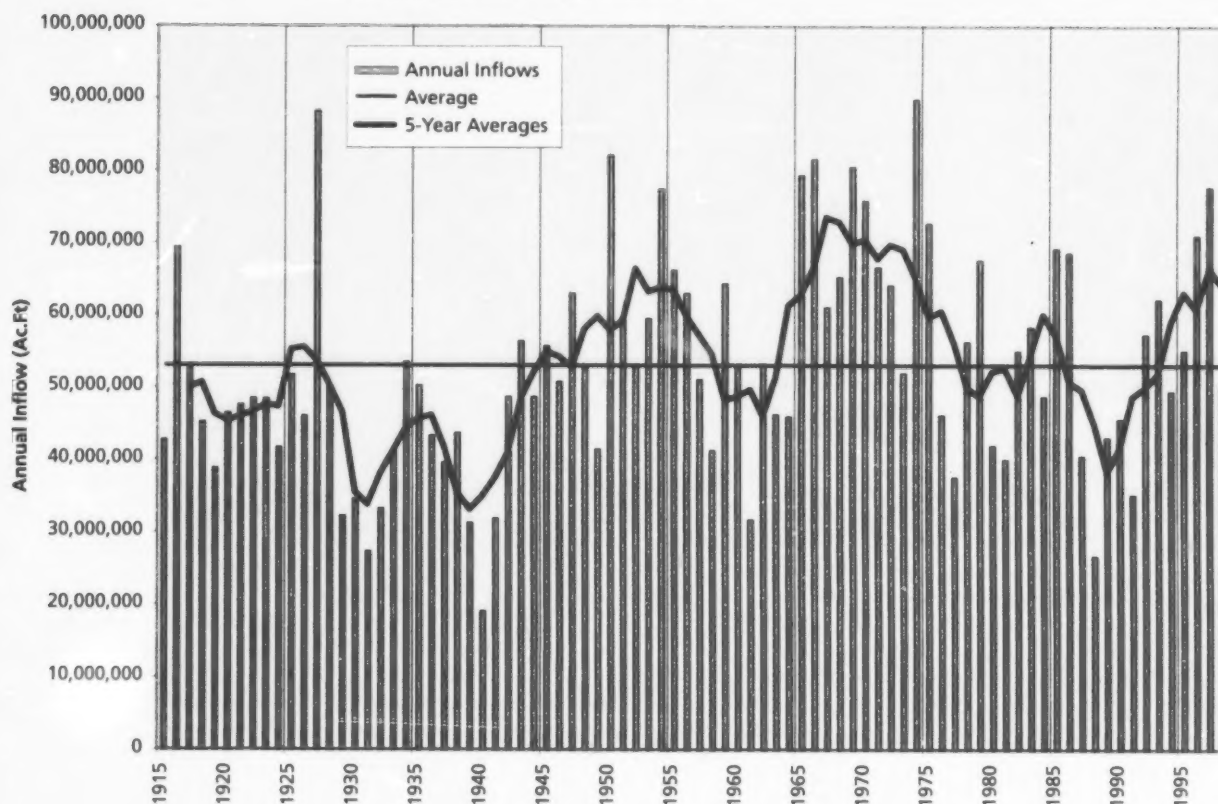
The following questions were asked of Water Resources Branch.

2a) Have the precipitation and inflows in the catchment area been greater than average since 1992?

Figure 8.3 shows annual inflows to Lake Winnipeg for the period 1915 to 1998. The annual flows from 1959 to the present were computed by adding the total outflow from the lake to the annual change in storage in the lake. As a comparison, the flows for all of the rivers flowing into the lake that have flow records were added together. The results were very similar, but consistently lower, because of the ungauged tributaries.

**Figure 8.3 - Lake Winnipeg Total Annual Inflows
1915 to 1998**

(Source: Manitoba Water Resources)



There is insufficient recorded flow data before 1959 to accurately compute inflows using the method described above. Therefore, a series of water level versus outflow relationships developed by Water Survey of Canada in 1969 were used for the lake under unregulated conditions. These relationships were applied to the recorded average monthly levels to compute average monthly outflows and total annual outflows. Again, the annual changes in storage on the lake were added to the computed annual outflows to provide estimated annual inflows. These curves for

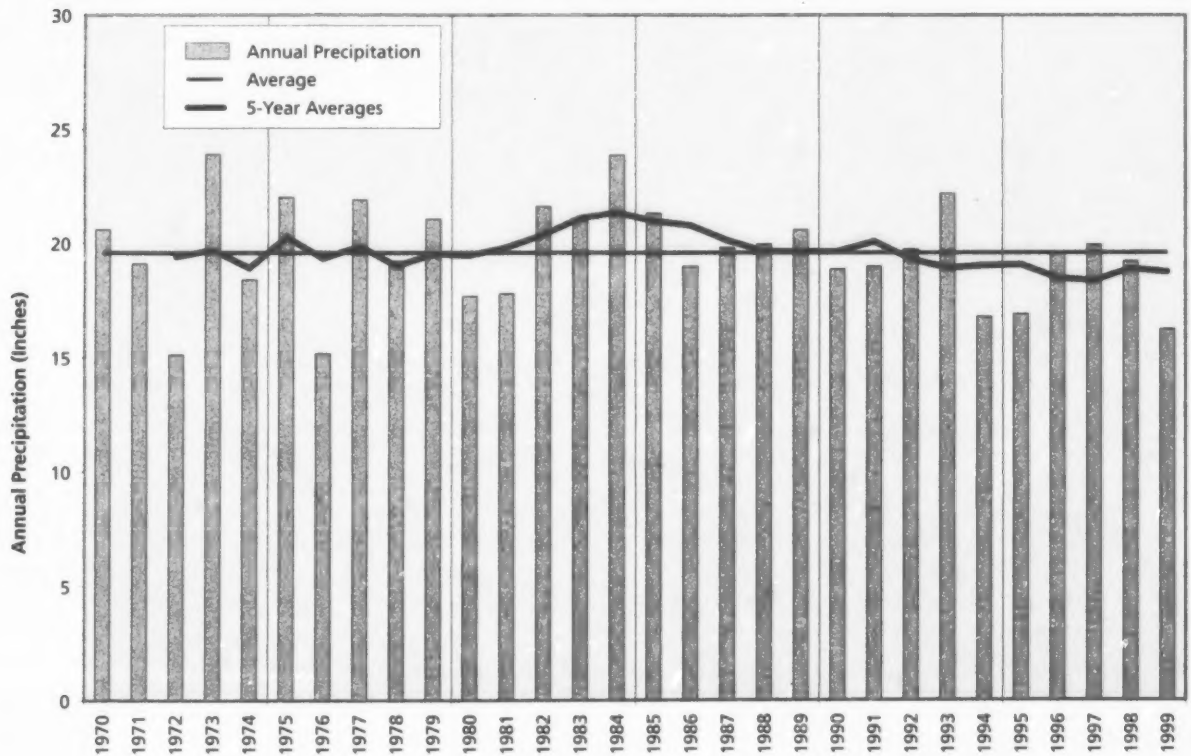
computing unregulated outflows are recognized to be imprecise. The historic relationship between Lake Winnipeg levels and outflows was variable because of factors like weed growth in Playgreen Lake. However, the computed annual averages should still be reasonably accurate, because the relationships were developed based on a best fit of the full data record.

This plot (Figure 8.3) shows the annual inflow volumes as well as the five-year moving averages. The moving average trace shows the multi-year trends in inflows. It shows that inflows were above average during the 50's, during the mid 60's to mid 70's, and for the last few years.

Specifically, since 1992 the average annual inflow has been 60.5 million acre-feet, or 14% above the long-term average.

Figure 8.4 shows total annual precipitation over Lake Winnipeg from 1970 to the present. Again the chart shows the annual totals plus the five-year moving averages. Interestingly, these precipitation totals are less variable than the total inflows. Also for the period from 1992 to 1999, precipitation over the lake has been slightly below average. Therefore, the fluctuations of the lake levels over this period are more a reflection of inflows from the total one million square kilometer drainage area, rather than from precipitation over the lake surface.

**Figure 8.4 - Lake Winnipeg Total Annual Precipitation
1970 to 1999**
(Source: Manitoba Water Resources)



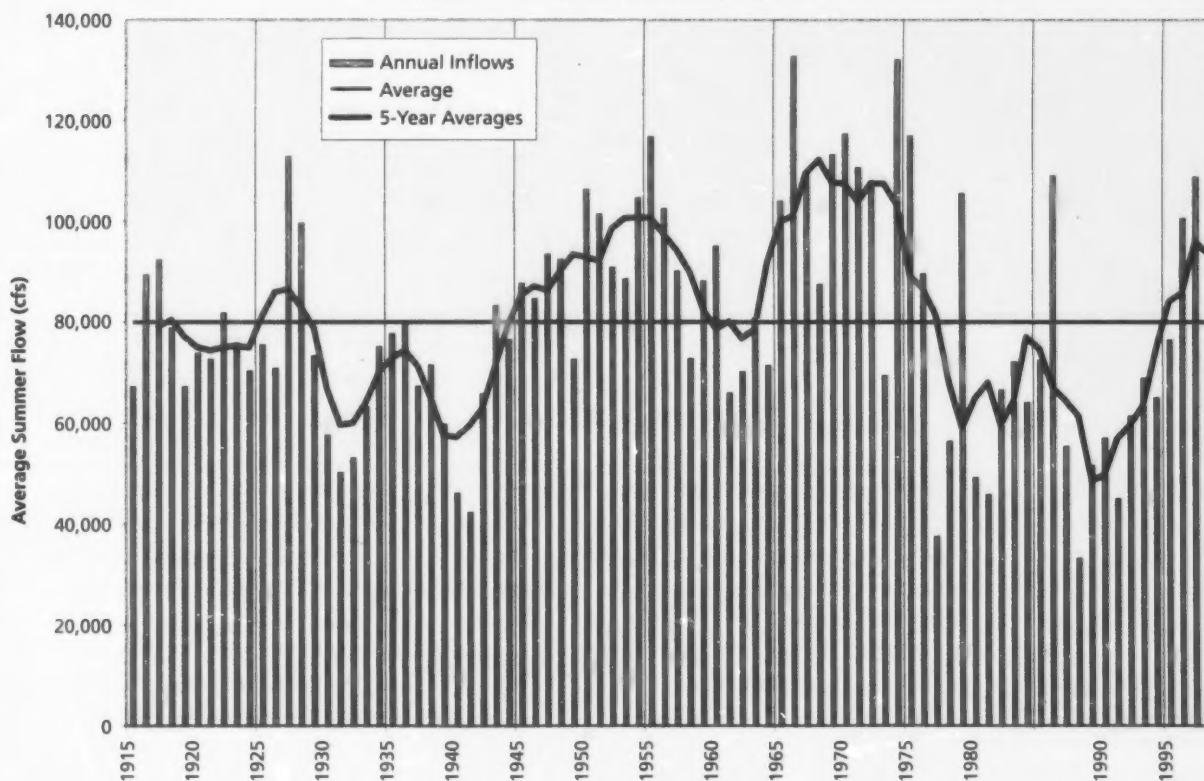
2(b) Have the summer and winter outflows from Lake Winnipeg been significantly different since 1992?

Figures 8.5 and 8.6 show average summer and winter outflows respectively from Lake Winnipeg for the period 1915 to 1998. The summer flows are the average flows for the months from April to October. The winter flows are the average flows from November to March of the following year. The pattern for summer outflows is very similar to the pattern for total annual inflows. The pattern for winter outflows shows a change in pattern in the mid 70's. Since regulation, the outflows have been above the long-term average in all but three years. This reflects the increased outflow capacity of the lake. Before regulation, the winter flows averaged 70% of the summer flow rates. Since 1976, the ratio has increased to 87% of the average summer flow rate.

For the period from 1992 to the present, summer outflows have averaged 80,000 cfs, which is about equal to the long-term average. Winter outflows have averaged 85,200 cfs, which is 34% above the long-term average.

**Figure 8.5 - Lake Winnipeg Annual Summer Outflows
1915 to 1998**

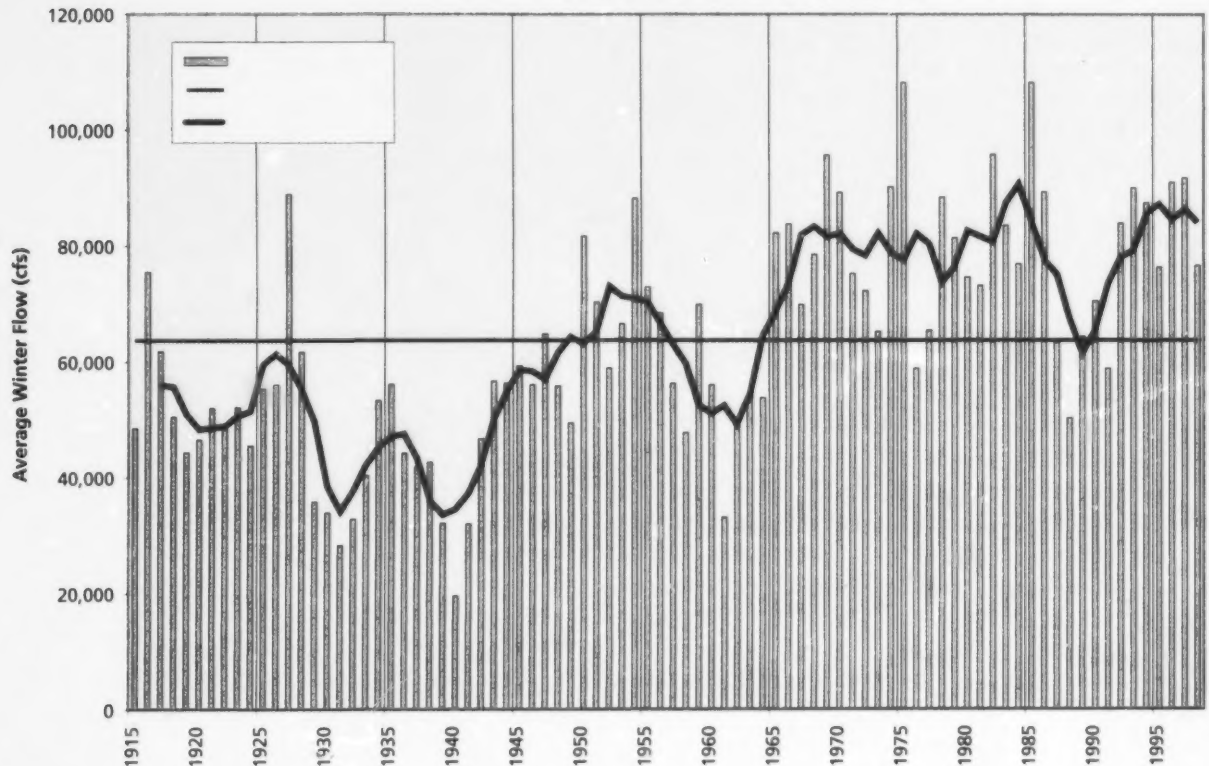
(Source: Manitoba Water Resources)



The figures also show a difference in both summer and winter outflows between the early regulation years (1976 to 1991) and the more recent period (1992 to 1998). For the summer period, average outflows from 1992 to 1998 were 26% higher than the average for the early regulation period. The winter flows for the recent period are 13% higher than for the earlier regulation period.

**Figure 8.6 - Lake Winnipeg Annual Winter Outflows
1915 to 1998**

(Source: Manitoba Water Resources)



2(c) Using suitable data (over-water wind events) has there been an unusual (greater than average) combination of high water and high winds since 1992?

Wind setup at the south end of Lake Winnipeg occurs when a sustained northerly wind forces water from the north basin of Lake Winnipeg into the south basin. Wind data for Lake Winnipeg, particularly over-water wind data, is sparse. However, a comparison between recorded lake levels and smoothed lake levels clearly shows the wind setup events on the south basin. Therefore an analysis was done of daily wind setups at the Gimli hydrometric station 05SG006 from 1974 to 1999. Wind setup events for the 18-year period from 1974 to 1991 were compared to wind setups for the period from 1992 to 1999 to see if there has been an unusually high number of wind setup events. The results are shown in Table 8.4.

Table 8.4 - Number of Occurrences of Wind Setup on Lake Winnipeg
(Source: Manitoba Water Resources)

Daily Average Wind Setup at Gimli (ft.)			
Lake Levels:	2 - 2.5 ft.	2.5 - 3 ft.	> 3 ft.
1974 - 1991			
<713.5 ft.	3	3	0
713.5 - 714 ft.	2	0	0
714 - 714.5 ft.	0	0	0
714.5 - 715 ft.	0	0	0
>715 ft.	0	0	0
1992 - 2000			
<713.5 ft.	1	0	1
713.5 - 714 ft.	2	0	0
714 - 714.5 ft.	2	1	1
714.5 - 715 ft.	1	0	0
>715 ft.	0	0	0

The results show an increase in the severity of wind setup events in the later period. During the 18-year period from 1974 to 1991, there were eight major wind setup events. The nine-year period from 1992 to 2000 also had nine major wind setup events, representing a more than doubling in the frequency of occurrence. Also, the table shows that in the later period more wind setup events happened during periods with higher lake levels. From 1974 to 1991, no wind setups greater than 2.5 feet occurred when lake levels were above 713.5 feet. During the period from 1992 to 2000, two wind setups greater than 2.5 feet occurred when lake levels were above 714 feet.

The ten largest annual and annual fall setup events are shown in figures 8.7 and 8.8. From these it may be seen that three of the ten largest wind setup events have occurred since 1993 in each case.



Table 8.4 - Number of Occurrences of Wind Setup on Lake Winnipeg*(Source: Manitoba Water Resources)*

Daily Average Wind Setup at Gimli (ft.)			
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714.5 - 715 ft.	0	0	0
>715 ft.	0	0	0
1992 - 2000			
<713.5 ft.	1	0	1
713.5 - 714 ft.	2	0	0
714 - 714.5 ft.	2	1	1
714.5 - 715 ft.	1	0	0
>715 ft.	0	0	0

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The ten largest annual and annual fall setup events are shown in figures 8.7 and 8.8. From these it may be seen that three of the ten largest wind setup events have occurred since 1993 in each case.

**Figure 8.7 - Maximum Annual Wind Setup Events
Winnipeg Beach/Gimli**

(Source: Manitoba Water Resources)

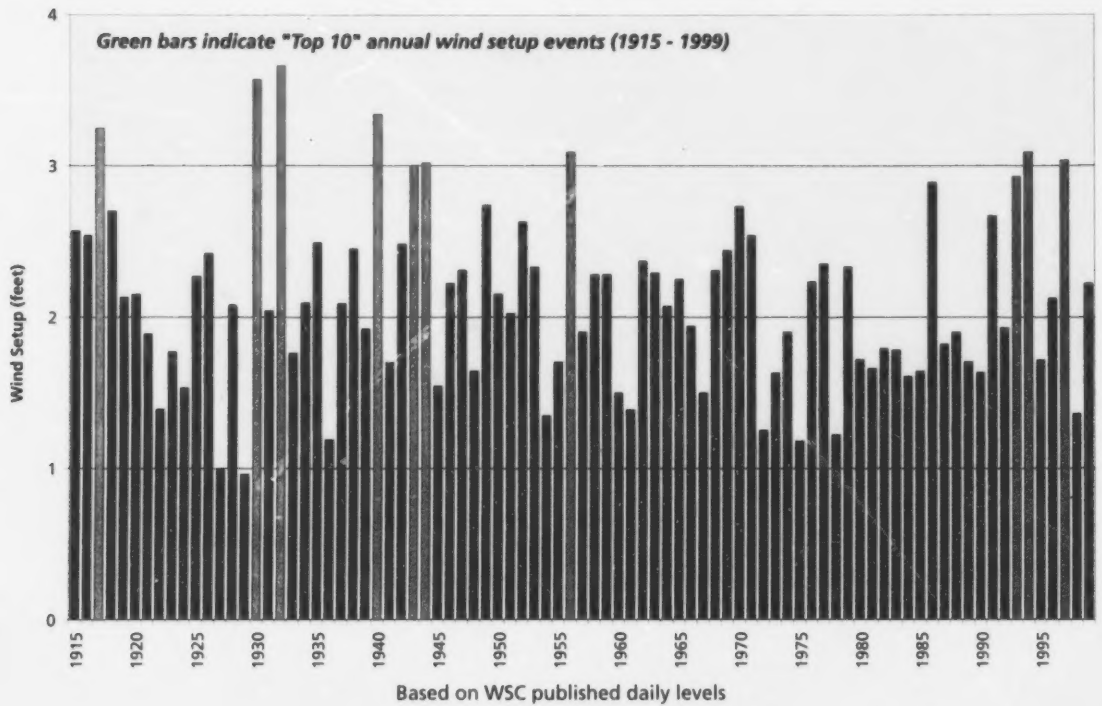
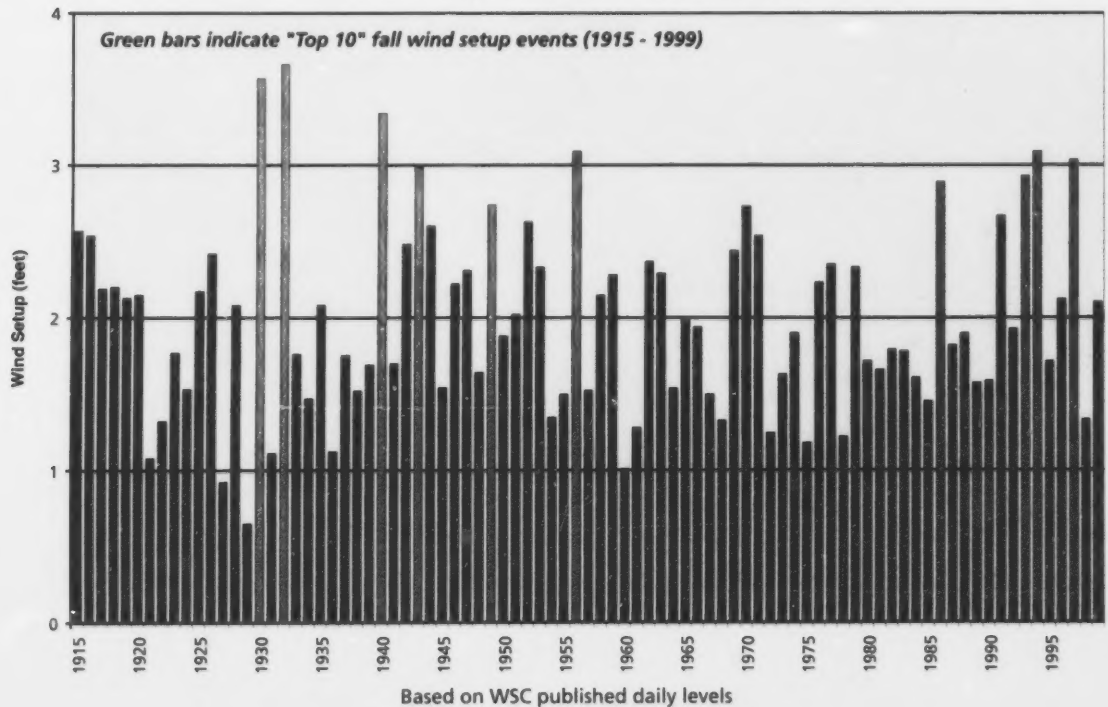


**Figure 8.8 - Maximum Annual Fall Wind Setup Events - Winnipeg Beach/Gimli
September to November Period**

(Source: Manitoba Water Resources)



2(d) Were the precipitation and inflows in the catchment area greater than average for the period 1972 - 76 inclusive?

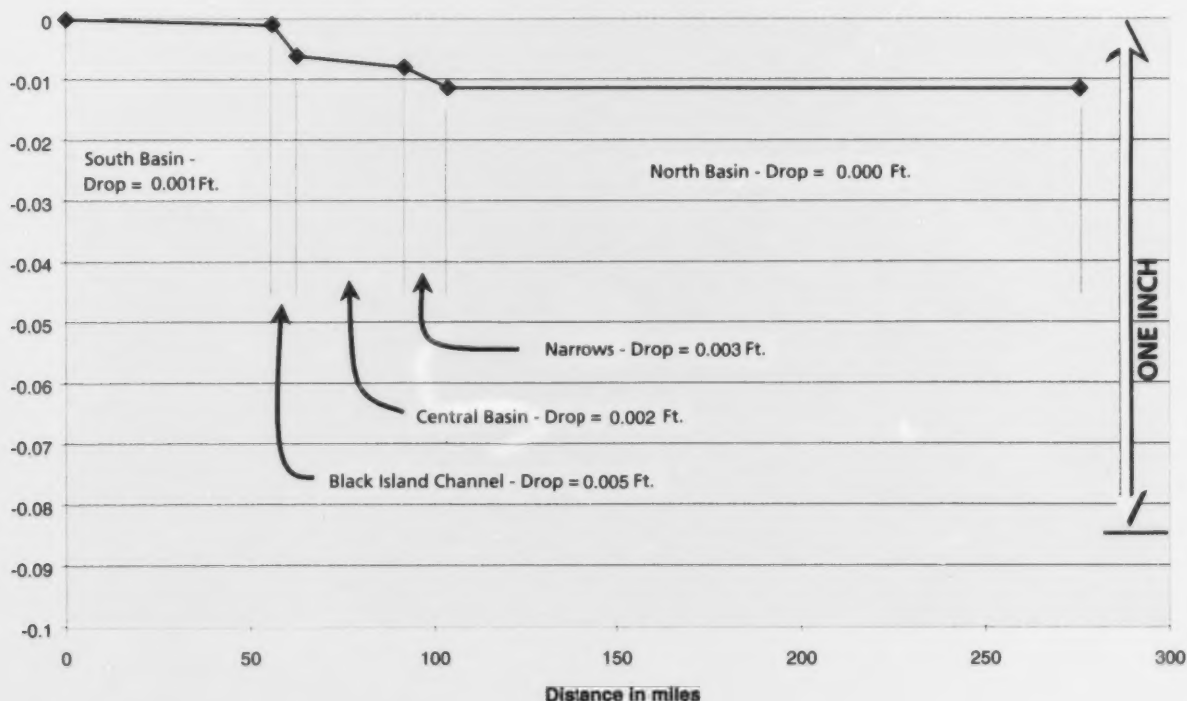
Over the five-year period from 1972 to 1976, the annual inflows to Lake Winnipeg averaged 65 million acre feet, or 22% higher than the long-term average inflow. This is close to the highest five-year average over the period of record.

In response to question 1(d) regarding the slope of the lake surface, Water Resources Branch stated the following:

In regards to the validity of the assumption that in the absence of wind or air pressure differences, the lake surface would be flat, it is recognized that flowing water slopes down-hill because of the natural resistance in the flow channel. The widely-used Manning's equation was applied to the surface of Lake Winnipeg assuming an inflow to the south basin of 150,000 cfs. This inflow would represent a typical high spring flow into the lake. The results are shown in Figure 8.9. The computation shows that for a flow of this magnitude the total drop in water surface over the full length of the lake would be just over one-hundredth of a foot, or approximately the thickness of two quarters. It is therefore reasonable to assume that in the absence of wind or air pressure differences the lake would be essentially flat.

**Figure 8.9 - Effect of Flow Rate on Lake Winnipeg Surface Slope
Flow of 150,000 cfs**

(Source: Manitoba Water Resources)



9 Shoreline Protection Options

9.1 The effectiveness and impact of current shoreline protection structures

A review was undertaken of shoreline protection measures now in place in the south basin. The review consisted of traversing the shoreline in late winter on all-terrain vehicles and completing the survey by boat later in the spring of 2000.

There is a significant difference between the east and west shores of the south basin.



Installing french drains

The soil profile along the west shore consists of a shallow depth (1 to 20 feet) of lacustrine clay underlain by clay till. Bedrock does not outcrop along the shore profile. The lacustrine clay is stone-free and highly erodible. The till contains significant quantities of sand, gravel and boulders. The quantity of coarse particles - sand, gravel and boulders - remaining after the fine grained particles have been washed away varies along the shore. Where till ridges outcrop along the shore, this quantity is sufficient to provide a continuous cover on the beach and to retard or inhibit further erosion. The elevation of the land adjacent to the shoreline varies from 720 to 740 ft. asl.



A gabion seawall - west side of lake.

The elevation of land fronting on the south shore is at or near the lake level, except for an almost continuous sand dune which has developed behind the sand beach. The soils underlying the beach and sand dunes are lacustrine clays and silts. Some areas have extensive peat cover.

The soils along the east shore are more variable and complex. These include glacial outwash deposits consisting mainly of sands, lacustrine clays and silts, and boulder rich clay tills. Most of the headlands on the east side are clay tills armoured with large boulders. Only at the southwest corner of Elk Island does bedrock outcrop above the water level. The elevation of land fronting on the east shore varies from about 720 ft. asl at the south to about 770 at Elk Island.

Figure 9.1



Results of Review

A significant portion of the erosion-prone shoreline has some form of shoreline protection in place.

An estimated eighty to ninety per cent of the west shoreline is protected to some extent along built-up areas from Netley Marsh to, and including, Spruce Sands, except for a stretch of beach from south of Camp Morton to Glen Bay. North of Spruce Sands, development is generally sparse with very little shoreline protection in place except for a few scattered groynes. The eastern shoreline has a much smaller percentage of its built-up area protected, and much of the protection is in the form of groynes rather than alongshore (parallel) protection.

On both sides of the lake, however, undeveloped shoreline is usually unprotected and in these areas, the beaches still remain. See Figure 9.1

There is a wide range in the scale of shoreline structures. Structures range from modest placements made by hand, to substantial structures requiring the use of heavy equipment. Many different types of shoreline protection exist. These include rip-rap, revetments, groynes and various forms of seawalls. Seawalls are made from gabions, concrete, wood piles and steel sheet piling.

A range in the quality and effectiveness of shoreline protection is evident. Some of the worst shoreline protection consists of construction waste and concrete rubble, complete with protruding re-bar, dumped on the beach. Other protection measures consist of small (less than 12 inch) rocks and boulders that have been known to fail under storm conditions. However, there are also examples of carefully constructed shoreline protection made with large stone (e.g. 3 foot diameter) and filter fabric, placed to form a proper revetment as well as substantial concrete and steel seawalls. The Stanted/Baird report notes that some (or most) of the types of structures now in use on Lake Winnipeg provide little long term protection and *have resulted in, or will result in ruining the use and enjoyment of Lake Winnipeg beaches.*

Placement of structures is uncontrolled. There is an almost complete lack of guidance provided to municipal governments and individuals as to legislation and regulation governing the placement of structures on the Lake Winnipeg shoreline. The practice has been to allow property owners to do whatever they feel is in the best interests of protecting the shoreline in front of their own property. This has resulted in the haphazard construction of various types of structures along a significant part of what is likely "public reserve". Municipalities have participated in this practice by constructing groynes in response to concerns about erosion. There is little evidence that groynes as currently designed and constructed provide any benefit except in the occasional circumstance. *In some cases, shoreline protection measures protecting one property have a negative effect on neighboring properties.*



Example of a groyne

9.2 W.F. Baird & Associates Coastal Engineers Ltd./Stantec Consulting Ltd. "Lake Winnipeg Shoreline Erosion Study"

The Lake Winnipeg Shoreline Erosion Advisory Group selected Stantec Consulting Ltd. in association with W. F. Baird & Associates Coastal Engineers Ltd. to develop appropriate shoreline management options. Their report is available as Technical Report 5.

The report describes the geologic setting and the general shoreline characteristics of the south basin. It also examines erosion factors through a discussion of shoreline processes including controlling substrate, wind setup, waves, sediment transport, ice and other factors such as groundwater and vegetation. It emphasizes that a good understanding of erosion processes on large inland glacial lakes is crucial to the development of effective long-term protection measures.

A significant amount of the Lake Winnipeg south basin shoreline is developed with homes and cottages. Wave action combined with variable water levels causes erosion along the lakeshore. To control erosion, many property owners have constructed various types of structures, many of which have been ineffective or have caused adverse impacts elsewhere.

Representatives of Stantec/Baird along with members of the Advisory Group visited the worst impacted areas along the south basin and selected six representative sites for functional designs of shoreline management options.

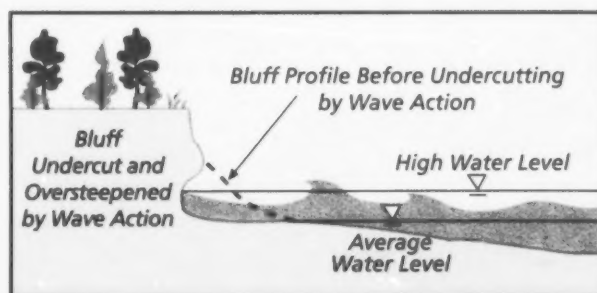
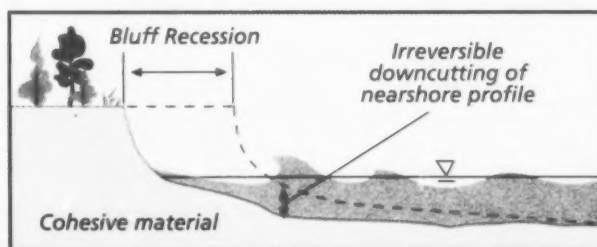
A discussion of nonstructural and structural shoreline management practices is presented with an emphasis on the use of nonstructural solutions where practical.

The shoreline is classified into 12 types for purposes of designing shoreline protection.

Controlling Substrate

The controlling process for the recession or erosion of a cohesive shoreline is the downcutting or downwards erosion of the nearshore profile by wave-induced forces. Cohesive shoreline bluffs are common along the south basin. Erosion or downcutting of cohesive shorelines is irreversible, since the silt and clay particles which dominate the shoreline material cannot be "stuck back together."

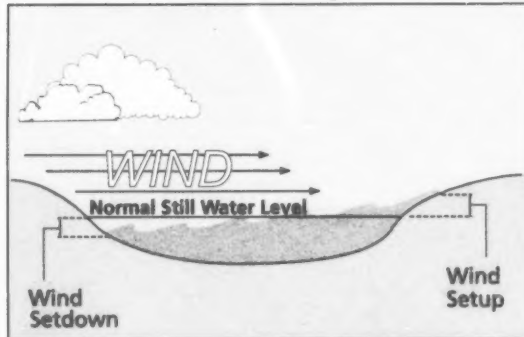
Dynamic sandy shores or muddy shores may either be accreting, eroding or remaining stable depending on the long-term supply of sediment to the beach or muddy nearshore area. Bedrock shorelines are erosion resistant and thus highly stable.



Water Levels

Erosion can be influenced by both long- and short-term water levels. Since regulation of the lake, variation of the mean monthly lake level has been reduced. The long-term average level of the lake for the periods both before and after regulation are similar with both being about 713.5 ft. The actual values vary depending on the time period of comparison.

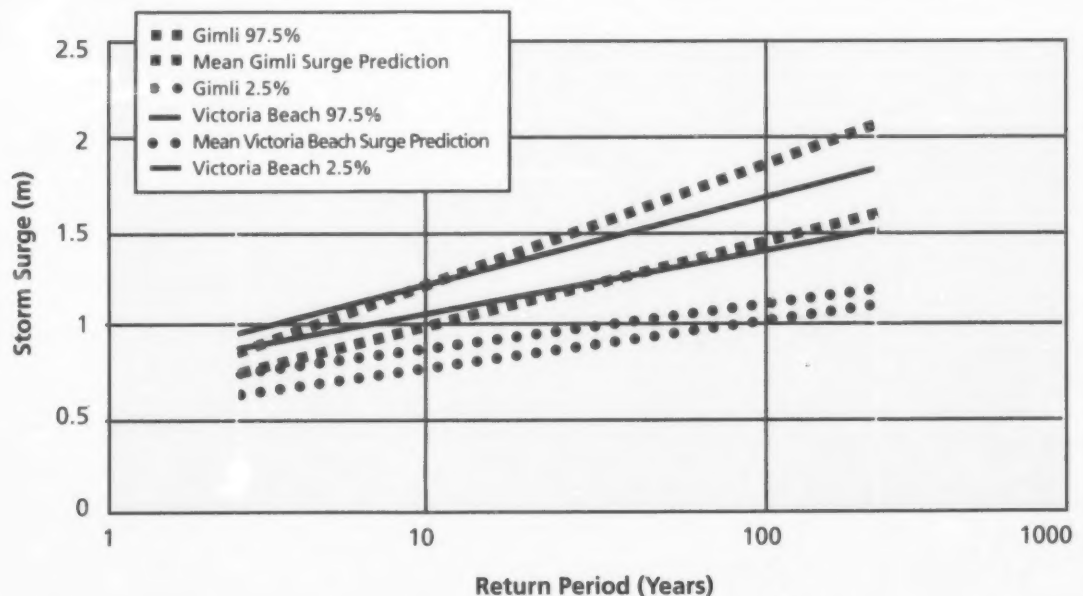
Wind Setup



Short-term fluctuations in water levels are influenced by wind and atmospheric pressure with the main influence being strong winds.

During the 18-year period from 1974 to 1991, there were 8 wind setup events greater than or equal to 2 ft. In the 8-year period from 1992 to 1999, there were also 8 events greater than or equal to 2 ft. From 1974 to 1991, no wind setups greater than 2.5 ft. occurred when mean lake levels were above 713.5 ft. During the period from 1992 to 1999, 2 wind setup events greater than 2.5 ft. occurred when mean lake levels were above 714 ft.

Figure 9.2 - Wind Setup Return Periods at Gimli and Victoria Beach



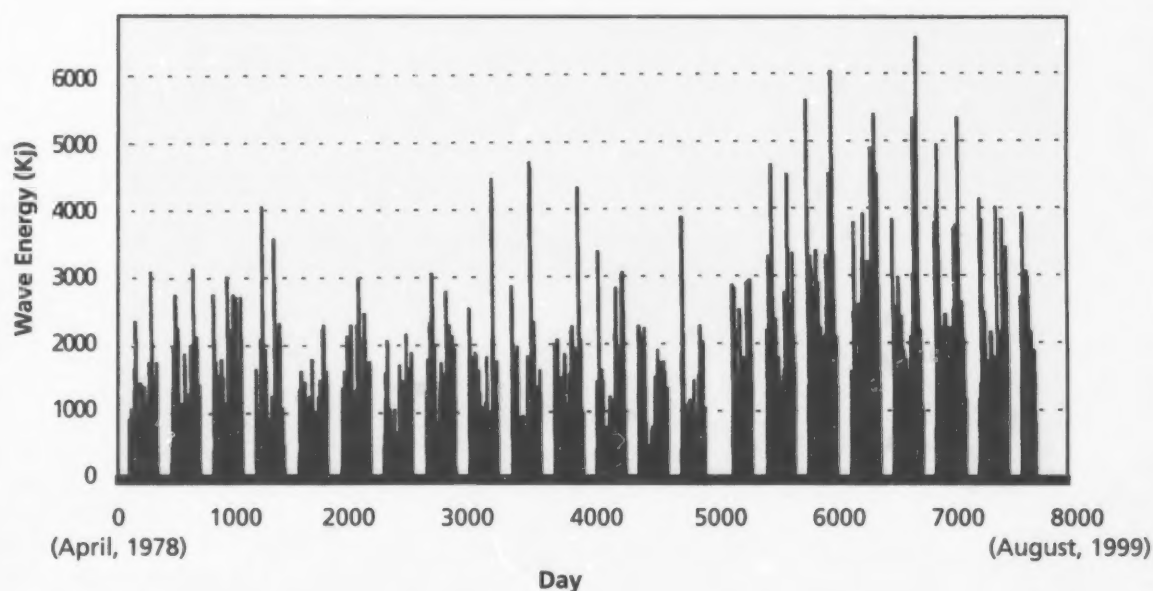
It is important to note that local fluctuations in the water level occur rapidly and are of such magnitude that regulation of the lake on a day-to-day basis cannot offset these variations. Water levels in the south basin may change at a rate of up to one foot per six hours due to wind setup. However, the lake level may only be lowered by a few millimeters over a period of days.

Another factor influencing lake levels is known as the seiche effect. The primary factor influencing or causing seiche effect is wind-induced water level changes, which result in oscillation in lake levels similar to the sloshing that occurs in an enclosed tank of water.

Wave Climate

Wave climate is a significant factor in shoreline erosion and in the design of shoreline protection measures. For purposes of shoreline protection design, a "significant wave height" is calculated. The significant wave height is defined as the average of the highest one-third of all the waves in a given series of waves. It is important to note however, that the maximum wave height in the series can be 1.5 to 2 times greater than the significant wave height. It is evident from the Figure 9.3 that wave energy varies by month and by year. A clear trend of increased wave energy during the late fall and spring months can be observed.

Figure 9.3 - Site 2 - Lester Beach: Deep Water Wave Energy



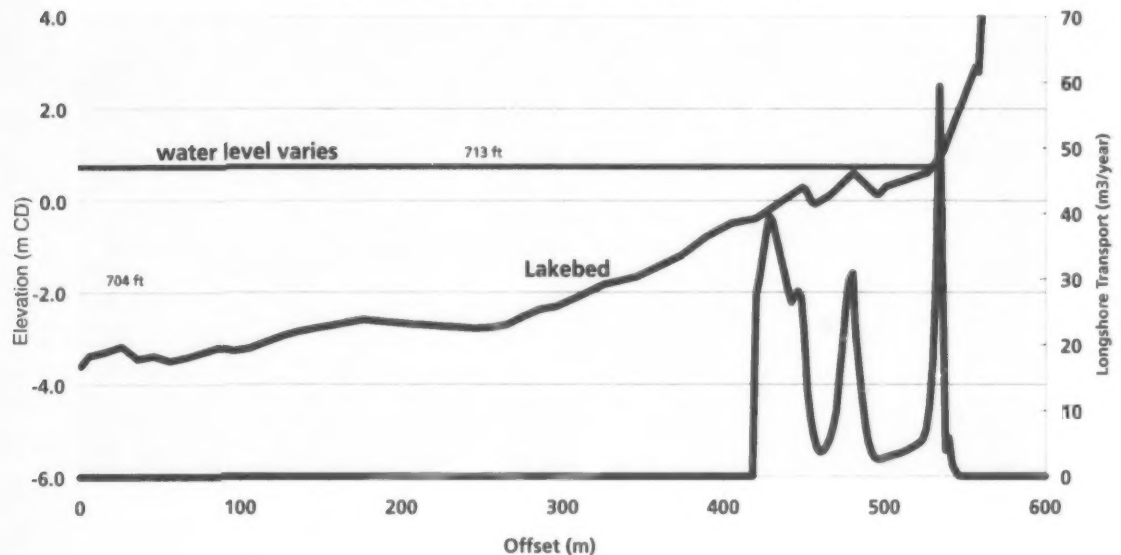
Historic Shoreline Recession Rates

The historic shoreline recession rate is an important element to be considered in the design of shoreline protection. Erosion rates can vary widely from year to year. Lakeshore conditions may often show little change for many years and then will erode rapidly under conditions of severe wave action and/or high water levels. Penner and Swedlo indicated in 1974 typical shoreline recession rates of 1ft/yr. to 2ft/yr. with extremes of 0ft/yr. to 25ft/yr.

Alongshore Sediment Transport

Erosion, transport and deposition of sediments in the beach and nearshore zone are primarily driven by wave orbital motion and wave-generated currents. Sediments are transported alongshore when waves approach at an angle to the shoreline and a portion of the momentum of breaking waves is directed alongshore. This results in the generation of alongshore currents in the direction of wave approach. Figure 9.4 shows an example of the distribution of the alongshore sediment transport at Site 5, Spruce Sands.

Figure 9.4
Profile - Azimuth 102 deg. $D_{50} = 0.25$ mm
Annual Alongshore Transport to North ($2000 \text{ m}^3/\text{year}$)



Other Erosion Factors

Other factors affecting erosion include the presence and movement of groundwater in bluff areas, tableland surface water and vegetation. The presence of groundwater in a bluff reduces its ability to resist collapse due to the lubricating effect that a high water content has on the soil. The flow of surface water down the face of a bluff can also lead to erosion of a bluff face and ultimately to varying degrees of bluff failure. Care must be taken in the design of tableland water drainage networks so they do not aggravate this problem. Vegetation cover on a slope is an important defense against soil erosion and is very important to long-term erosion protection. Vegetation protects against surface erosion and shallow translation slope slides by:

- holding, binding or reinforcing the soil with a root system;
- removing water from the soil by uptake and transpiration;
- reducing runoff flow velocity;
- by reducing frost penetration; and/or
- by the buttressing or reinforcing of large tree roots.

Shoreline Management Options

Six sites were selected as representative of the various shoreline types around the south basin for the functional design of shoreline management options. These sites are Traverse Bay, Lester Beach, Halcyon Cove, Matlock, Spruce Sands and Hnausa.

Shoreline management options can be classified in a number of ways. For the purpose of this report they are classified as follows:

Nonstructural

- Prevention (setbacks, minimum elevations).
- Relocation.
- Onshore grading and vegetation.
- Dune enhancement.

Structural

- Replicate natural processes (beach nourishment, lakebed armouring).
- Work with natural processes (groynes, artificial headlands, detached breakwaters).
- Oppose natural processes (revetments, seawalls).

Each of the above options is described in detail in the Stantec/Baird report.

General Considerations

Consider the Long Term Average Erosion Rate

Consider the total amount of shoreline erosion that is likely to occur over the next 20 to 50 years. The rate of erosion may vary greatly from year to year. Do not consider short time periods of minimal or no erosion as an indication of the real extent of the erosion risk. On the other hand, significant and alarming erosion often occurs during storms at high water levels, which occur at infrequent and unpredictable intervals.

Consider Prevention and Relocation

The preferred, and often the most appropriate shoreline management approach, is prevention, that is, locating development landward of the shoreline hazards. In areas of existing development, relocation should be given serious consideration, where practical.

The advantages of prevention and relocation over structural protection works are:

- Greatly reduced construction, maintenance and structure replacement costs.
- No negative impacts to the environment or downdrift shoreline.
- Natural aesthetics and amenities of the beach at the shoreline are preserved.
- No need for approval of structure construction.

Figure 9.5 - Selection of a Shoreline Management Approach

General Considerations

- | | |
|--|-------------------------|
| 1) Long-term Erosion | 4) Total Cost |
| 2) Prevention & Relocation versus Structural | 5) Impacts |
| 3) Effects on Beach | 6) Coordinated Approach |

New development

or

Existing Development

Prevention set backs

- Flooding
- Erosion
- Dynamic Beach

Maintain status quo

- shoreline recession continues
- risk of damage increases with time
- natural shoreline maintained

ORDER

OF

PREFERENCE

Relocate building away from shoreline

- shoreline recession continues
- risk of damage put off until later date
- natural shoreline maintained

Structural shoreline protection

- shoreline recession arrested for a period of time
- nearshore erosion continues
- risk of damage reduced for life span of protection structure
- beach and shoreline processes impacted

Consider the Effect of the Structure on the Beach

The beach is a significant part of the attraction of shorefront property. When the landward movement of an eroding shoreline is arrested by a structure, the unprotected area in front of the structure continues to erode and deepen. Any beach in front of an armoured shoreline will normally diminish in width over time, as the nearshore profile erodes and the beach will eventually disappear. The beach loss may be accelerated by wave reflection from the structure.

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- No negative impacts to the environment or downdrift shoreline.
- Natural aesthetics and amenities of the beach at the shoreline are preserved.
- No need for approval of structure construction.

Consider the Total Cost

Shoreline owners often construct protection structures with little or no consideration of the total cost of maintaining, repairing and replacing the structure for the full life of the development. Owners should critically and objectively evaluate the total costs and benefits of proposed erosion protection structures. This is often very difficult as a result of emotional attachments to lakeshore property that has built up over years or even generations. Many individual property owners invest such large amounts of money in protection, including materials, construction and future maintenance that they essentially "rebuy" their house or cottage and land every 20 years and in most cases their land continues to erode.

Consider the Impacts

Structural protection works are most commonly associated with effects on the physical shoreline environment such as reducing sediment supply by stopping bluff erosion, and trapping and or deflecting alongshore sediment transport. Changes in the physical processes due to structural protection works may also result in a range of potential impacts on the terrestrial and aquatic environment.

Consider Coordinated Efforts with Adjacent Properties

To be most effective, shoreline protection works must be coordinated with the adjacent properties. The lack, or the level and type, of protection at adjacent properties must be considered in the design of, or the decision to build protection works. Erosion protection along a single, narrow lot may be of little value, even if flank protection is provided, if the adjacent properties are not protected.

Deciding on a Response

Prevention

Development practices should adapt to the natural shoreline processes and be setback from the shoreline beyond the limit of the flooding, erosion and dynamic beach hazards.

Maintain the Status Quo

In many cases a careful review of long-term erosion rates, the impact of protection structures on beaches and the total cost of the structure relative to the land will indicate that the best course of action is to maintain the status quo; that is, to do nothing and allow the natural erosion to occur.

Replicate the Shoreline Processes

The best approach to arrest shoreline erosion is to replicate the natural shoreline processes through beach nourishment and/or lakebed armouring. These two options require significant further study to determine their viability as long-term shoreline management options for Lake Winnipeg. If feasible, they would typically be applied on a much larger scale than one individual property owner.

Work with Natural Processes

Groynes, detached breakwaters and artificial headlands all attempt to retain beach material at a given site. However, there can be serious limitations with these structures. They require extensive design studies and are likely beyond the scope of the individual property owner. Groynes extend perpendicular to the shore and may impede access along the beach.

Groynes are intended to trap alongshore beach material. Where this material is available, the trapping will result in less beach sediments at the downdrift shorelines. Trapping will continue until the compartments of a groyne field are filled and bypassing occurs. Groynes will not work if there is minimal or no natural alongshore transport of suitable beach material now or in the future, as is the case along many of the cohesive shorelines of Lake Winnipeg. Groynes do not attract beach material that does not exist. This can be a substantial concern in areas where increasing shoreline protection further decreases an already limited sediment supply.

In addition to the trapping of sediment, the construction of groynes may result in currents that deflect the alongshore littoral transport from near the shoreline to the nearest nearshore bar in deeper water. In deeper water, it is more difficult for the waves to move the materials back to the shoreline. Thus the material is moved along the bar, past downdrift properties, and is only slowly returned to the shoreline further downdrift. The offshore diversion of the littoral material results in a deficit of material immediately downdrift. The immediate downdrift properties will experience an on-going sediment deficit even after bypassing around the updrift structures occurs and even if the updrift structure is pre-filled. The diversion and the resulting sediment deficit will continue as long as the updrift structure is in place.

Typically, groynes on Lake Winnipeg are much shorter than 50 to 100 feet. These typical lengths are too short to effectively protect the nearshore profile of cohesive shorelines from downcutting. To be effective as shoreline protection, groynes would typically have to extend beyond a depth of 8 to 12 feet (2.4m to 3.7m) below mean lake level. To reach these depths would require much longer groynes, which in turn may result in serious downdrift impacts.

Groynes, including pre-filled groynes, are easily emptied of the protective beach material at times of rising water levels when cross-shore transport during storm events moves the material offshore beyond the end of the groyne. Short groynes have a problem trapping sand, particularly if the beach is backed by a reflective structure. At many areas around Lake Winnipeg, the distribution of the alongshore transport extends a considerable distance offshore with a significant portion of the transport occurring lakeward of the ends of the groynes. Therefore, any material moved offshore beyond the end of the groyne will be quickly carried away as alongshore transport.

In summary, it is expected that groynes would generally not be considered as long-term shoreline protection solutions along the cohesive shores of Lake Winnipeg. Further discussion of the characteristics of an effective groyne system are outlined in Section 6.2.2 of the Baird/Stantec report.

Oppose Natural Processes (armour the shoreline)

Where expensive structures or land are seriously threatened by erosion and where nonstructural measures and structural measures that replicate and/or work with the natural processes are not feasible, consider armouring the shoreline with structures that directly oppose the natural processes.

Revetments

Revetments are sloped structures with a protective layer of large "armour" stones that are built parallel to the shoreline to prevent the direct attack of waves on the toe of a bluff and the backshore. These structures rely on the mass of the armour stones to withstand the forces of the waves. As waves impact the structure, energy is dissipated as the water moves over the rough, permeable sloped face of the structure and through the voids between the armour stones. Armour stone revetments have advantages over other forms of shore protection because they can be designed to provide full protection to the bluff under any conditions encountered on Lake Winnipeg. This type of structure can also be designed to accommodate the ongoing erosion of the lake bottom near the shore, thus providing long-term protection to the backshore. However, this will have a significant impact on the capital construction cost, although annual maintenance cost will be reduced.



Concrete revetment

Revetments, like any other shore protection structure, have a number of disadvantages that make them inappropriate under some conditions. Unlike groynes, they may severely limit access to the beach and water and do nothing to increase the amount of recreation space. Beach or water access must often be provided by staircases or ramps located intermittently along the shoreline.

Armour stone revetments may be relatively expensive depending on the exposure of the site, the selected design life of the structure and the availability of suitable quarried stone material or boulders. In addition, access to the shoreline is required for large construction equipment.

Seawalls

Seawalls are vertical, sloped, curved or stepped shore-parallel walls that function in a very similar manner to a revetment.

Some property owners consider seawalls to be more aesthetically pleasing than revetments for a number of reasons. For example, seawalls allow people to be closer to the water and/or beach than a stone slope. It may also be easier to incorporate stairs or ramps for access to the water. Seawalls also require less width than a revetment, possibly making construction feasible in some areas with a steep backshore where a sloped structure might require large amounts of earth moving.

However, seawalls are generally less stable than revetments, and have a shorter life. In addition, seawalls, due to their steep (often vertical), impermeable and generally smooth face, cause more wave reflection, resulting in increased erosion in front of the structure and more problems with scour and undermining at the toe of the structure. Because of this, seawalls may fail catastrophically if not properly designed. Seawalls also require higher crests than revetments to prevent overtopping.

Finally, the cost of a seawall may be less than, or greater than that for a revetment depending on the site conditions and required life of the structure. Large seawalls can be very complicated to build, requiring anchoring of the walls to prevent overturning and/or very deep penetration depths for pile structures.



Steel Seawall

Based on the preceding discussion, in particular the possibility of increase nearshore erosion due to wave reflections, it is recommended that revetments be constructed rather than seawalls. This recommendation applies to both long-term erosion protection and storm wave runoff protection.

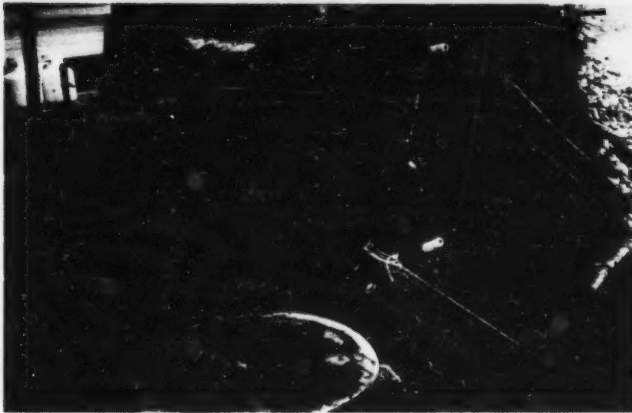
Bulkhead walls may be utilized for protection against storm wave runoff as long as they are located sufficiently landward of the shoreline such that they are not exposed to direct wave attack, and only to wave runoff during extreme conditions.

Conclusions of the Stantec/Baird Report

1. Significant portions of the shoreline of Lake Winnipeg are eroding because of the cohesive nature of the shoreline material, the action of the waves and the influence of the water levels and ice. Transgression of the shoreline is also occurring as a result of long-term increases in the mean water level due to climatic variations and isostatic rebound.
2. Flooding of low-lying areas adjacent to the shoreline is a result of various high combinations of mean water levels and short-term water level fluctuations.
3. In most instances, erosion, flooding and dynamic beach changes at the shoreline are primarily, and at least to a very large extent, the result of naturally occurring processes. Man-made alterations to the natural lake systems may, but typically to a much lesser degree than the natural processes, affect the extent of erosion, flooding and dynamic beach changes.
4. "Cohesive shores" are those shores that feature a thin layer of sand over clay or glacial till in the nearshore. The erosion of the cohesive nearshore profile is ongoing and irreversible. Once eroded, the clay and silts are transported into deep water and are never returned to shore. This process is the natural progression of a glacial lake such as Lake Winnipeg.
5. Mean water levels on Lake Winnipeg are primarily governed by climatic factors such as precipitation, evaporation and inflow. Prior to regulation, the monthly mean water level varied by over eight feet. Over the longer term, the effect of isostatic rebound is increasing water levels in the south basin of Lake Winnipeg at an estimated rate of 20 cm/century. The outflow has been regulated to some degree since 1976, which has had the effect of reducing the variability of the monthly mean water levels to within a range of about 4 ft.
6. Short-term water level fluctuations are caused by wind setup. A wind setup of one foot is common, and has reached as high as 3.7 ft. at Gimli/Winnipeg Beach.
7. Direct erosion of the shoreline bluffs and flooding of low-lying areas can be exacerbated by waves occurring at extremely high and extremely low water levels. From 1974 to 1991, no wind setups greater than 2.5 ft. occurred when lake levels were above 713.5 ft. During the period from 1992 to 1999, two wind setup events greater than 2.5 ft. occurred when lake levels were above 714 ft. (October 29, 1993 and November 2, 1997).



Natural shoreline erosion



Erosion at Morden's Meadows

8. Consider the total amount of shoreline erosion that is likely to occur over the next 20 to 50 years. The rate of erosion may vary greatly from year to year. Do not consider short time periods of minimal or no erosion as an indication of the real extent of the erosion risk. Significant and alarming erosion often occurs during storms at high water levels, which occur at infrequent and unpredictable intervals.
9. Development practices should adapt to the shoreline processes and be set back from the shoreline beyond the limit of the flooding, erosion and dynamic beach hazards.

10. Relocating an individual house or cottage at risk should be considered as a viable alternative when feasible.
11. Structural protection works that attempt to replicate the natural processes (i.e., beach nourishment and lakebed armouring) and structural works that attempt to work with the natural processes (i.e., detached breakwaters, artificial headlands and groynes) require detailed study and would typically be applied on a much larger scale than one individual property owner.
12. Many of the groynes constructed on Lake Winnipeg are ineffective because they are too short to trap enough sand to protect the cohesive nearshore profile and/or there is not enough beach material available in the littoral system to replenish the beach. Along shorelines with sufficient littoral transport, groynes negatively impact down drift areas by trapping material and thus reducing the sediment supply and by deflecting littoral material into deeper offshore water.



Shoreline protected with construction rubble

13. A properly designed, constructed and maintained revetment structure can effectively stop erosion at the water's edge for a period of time. Application of this approach requires careful consideration of the lake bottom erosion. A revetment can also be used to protect shorelines from storm wave runup damage, and can be designed to provide this protection even under extreme conditions. However, a revetment will not provide any recreational benefit to the shoreline, and may in fact reduce access and result in a reduction of existing beach deposits.

14. Armouring the shoreline with a revetment or seawall will arrest the bluff recession for a period of time but it does not reduce the erosion of the nearshore profile. Eventually, the structure will be undermined. The toe of a shoreline structure must be sufficiently embedded to allow for nearshore downcutting.
15. The beach in front of an armoured shoreline will normally diminish in width over time as the nearshore profile erodes. Beach loss may be accelerated by wave reflection from the structure. Sloping stone revetments result in less wave reflection than smooth, impermeable, vertical seawalls.
16. Protecting shorelines from erosion reduces the supply of sediment that helps to form the beaches.



Installation of drainage to prevent bank failure



Construction of sheet pile seawall



Wooden structure at Matlock



Seawall under construction, South Ridge

10 Findings & Recommendations

Findings

Lake Winnipeg is the eleventh largest freshwater lake in the world. With a surface area of 23,700 square kilometers, it stands as a major feature on the North American landscape. The lake is 430 kilometers long and has a maximum width of approximately 100 kilometers. It is divided into two relatively shallow basins. The shallow depth of the lake is a major contributing factor to the large wind setups which occur as a result of prolonged winds blowing from one direction. These setups contribute to erosion particularly during fall storms.

Manitoba Hydro regulates the lake for power production purposes under the terms of an interim licence granted in 1970 and a supplementary interim licence granted in 1972. The lake has been officially regulated since 1976.

1. Magnitude and Extent of Erosion

- Erosion of the Lake Winnipeg shoreline has been occurring since the formation of the lake and will continue into the future.
- The majority of the shoreline has experienced some amount of erosion. However, rates of erosion are uneven. There are areas of shoreline that are only lightly impacted by erosion and a lesser area of shoreline where erosion is significant. A few areas of the shoreline have experienced some accretion. From the sections of shoreline that were studied through use of air photos, erosion over a forty-year period ranged from zero in some locations to in excess of 100 meters in others.

2. Erosion Process

- In most instances, erosion, flooding and dynamic beach changes at the shoreline are the result of naturally occurring processes. The rate at which these processes occur can be influenced by a number of factors.
- The erosion process is complex. Erosion often starts underwater with nearshore down-cutting and only becomes apparent with episodic bank failures.
- Portions of the Lake Winnipeg shoreline are eroding because of the cohesive nature of the shoreline material, the action of waves and the influence of water levels and ice. Transgression of the shoreline is also occurring as a result of long-term increases in the mean water level due to climatic change and isostatic rebound. "Cohesive shores" are those that feature a thin layer of sand over clay or glacial till in the nearshore. The erosion of the cohesive nearshore profile is ongoing and irreversible - once eroded, the clay and silts are transported into deep water and never return to shore. This process is the natural progression of a glacial lake such as Lake Winnipeg. It is not known what impact lake level regulation may have on this process.

- Susceptibility to erosion depends largely on the soil profile of the shoreline. Under similar lake level and wind conditions, some types of shoreline are more prone to erosion than others. The erosion of some shorelines is also more sensitive to lake level variations than others, this is particularly true for shorelines in shallow bays. Each shoreline type requires a shoreline management approach that reflects site conditions.
- The "wind setup" effect where large volumes of water are pushed into the south basin is a contributing factor to erosion particularly in cases where significant wind events occur at the same time as high water. The maximum storm surge is of a similar order of magnitude to the range of mean lake level fluctuation.
- Direct erosion of the shoreline bluffs can be exacerbated by waves occurring at extreme water levels. From 1974 to 1991, no wind setups greater than 2.5 ft. occurred when lake levels were above 713.5 ft. During the period from 1992 to 2000, three wind setup events greater than 2.5 ft occurred when lake levels were above 714 ft. (October 29, 1993, November 2, 1997 and July 17, 2000).

3. Public Issues

- Property owners, First Nations and municipalities are very concerned with erosion of the Lake Winnipeg shoreline and the loss of beaches. This is a significant issue for property owners who have expressed a profound feeling of loss for both property and beaches.
- The public is of the opinion that erosion is increasing, and that the rate of that increase is accelerating.
- The public is also of the opinion that the erosion is caused by a combination of high winds and high water and that the solution is to lower the lake.

While this issue is outside of the mandate of the Advisory Group, the Group was provided with professional opinions that erosion will occur at any lake level, and that lowering the lake would only provide a respite for some period of years before the previous rate of shoreline recession is re-established. Raising the lake level will cause increased erosion for some period of time before returning to its historic rate. Lake levels held to a relatively constant level excepting storm surge can be advantageous with respect to minimizing erosion, but may endanger the health of marshes.

- The public has expressed the opinion that lake levels have been managed for the benefit of Manitoba Hydro and that the government is more concerned with Manitoba Hydro's profits than with the health of the lake. They also expressed the opinion that the lake has been regulated more aggressively since 1992.

An independent engineering analysis has established that long-term average lake levels are similar for both the pre- and post-regulatory periods. This applies to both annual and monthly averages. Since 1992, a period of above average inflow, the average lake level has been about 0.4 ft. above long-term average levels.

- The public is also of the opinion that there is nobody to effectively represent the interests of First Nations, property owners, commercial interests and people concerned with the environmental quality of the lake.
- There is widespread frustration among property owners, municipalities and aboriginal groups. This is partially due to the lack of advice available concerning design and construction of appropriate shoreline protection measures and partly due to public perception that regulation of the lake for hydro-electric purposes takes priority over shoreline erosion and environmental impacts.

4. Manitoba Hydro Methodology & Reporting

- Manitoba Hydro regulates lake levels within parameters established by a licence under the provincial Water Power Act. Regulation is based on "wind-eliminated" water levels. *An independent engineering analysis commissioned by the Advisory Group finds that Hydro's methodology for determining wind-eliminated levels provides a reasonably accurate representation of the wind-eliminated lake level.*

5. Water Level Reporting

- "Wind-eliminated water level" is a management tool associated with Manitoba Hydro's licence with little day-to-day relevance to property owners and municipalities. The concerns of property owners relate to actual water levels, not the wind-eliminated level as currently calculated and reported.

6. Shoreline Protection Measures in Place

- Shoreline protection measures in place vary widely in type, scale and effectiveness.
- While some shoreline protection measures have served to protect beaches and shorelines, many have been poorly designed and constructed and have created public safety hazards, created obstacles to the public use and enjoyment of beaches and may have contributed to erosion of neighbouring properties. Some actions taken to stop erosion may, in fact, be causing the destruction of some beaches.

7. The Shoreline Regulatory Environment

- The public and some municipalities have expressed frustration about the uncertainty of property ownership, regulations and jurisdiction governing the Lake Winnipeg shoreline, including the lack of approvals required for design and construction of shoreline protection struc-

tures. The practice has been to allow lakeside property owners to do whatever they deem to be in their own best interest. This has led to the construction of a wide variety of shoreline protection measures on public property and impediments to access and use of beaches and shorelines.

8. Shoreline Management Options

Shoreline management approaches have been identified for six different types of shoreline associations. These are:

Nonstructural

- Prevention (setbacks, minimum elevations).
- Relocation.
- Onshore grading and vegetation.
- Dune enhancement.

Structural

- Replicate natural processes (beach nourishment, lakebed armouring).
- Work with natural processes (groynes, artificial headlands, detached breakwaters).
- Oppose natural processes (revetments, seawalls).

9. Choosing An Approach

Selection of a shoreline management approach should include consideration of the long-term average erosion rate, prevention and relocation, effects of the structure on the beach, total cost, impacts such as increased flooding, erosion and dynamic beach hazards, and the coordination of efforts with adjacent properties.

Choices of how to deal with the problem may include:

- Prevent the problem by adapting development practices to the natural shoreline processes.
- Maintain the status quo and allow the erosion to continue.
- Replicate the shoreline processes.
- Work with natural processes.
- Oppose natural forces.

10. Environment

The public expressed frustration and raised questions and concerns about the environmental quality of Lake Winnipeg. While these are important issues, they are outside the mandate of the Lake Winnipeg Shoreline Erosion Advisory Group.

Consequently, the Advisory Group has not conducted any research into the environmental state of the lake or the environmental impact of existing erosion control measures. These are outstanding issues that need to be addressed through government-sponsored research, in cooperation with all levels of government, First Nation communities and residents of the area.

Recommendations

1. Advisory Board for Management of Lake Winnipeg

- It is recommended that an advisory board with an appropriate mandate be established. The purpose of the advisory board would be to:
 - provide a basin-wide forum to review and consider management issues relative to erosion and environmental issues;
 - prepare and implement an overall shoreline management plan, that will among other items include:
 - design and construction standards for docks, boathouses and similar structures;
 - standards for shoreline protection such as the location of groynes, public access to the shoreline, etc.,
 - a system for the approval of the design and construction of shoreline structures;
 - development standards for shoreline development. These standards should address issues such as building setbacks and elevations, sewage management and disposal and similar issues.
 - participate in a semi-annual review of lake levels; more frequently during unusual hydrological events;
 - monitor erosion;
 - monitor shoreline protection demonstration projects;
 - hold public meetings as necessary; and
 - coordinate development of technical support.
- Advisory Board members would include technical experts as well as stakeholders including representatives of:
 - municipalities;
 - First Nation communities;
 - planning districts;
 - Manitoba Water Resources;
 - Manitoba Hydro;
 - commercial interests such as commercial fishing and tourism;
 - environmental interests; and
 - private property owners.

2. Regulation of Shoreline Structures

- Regulations and/or legislation should be enacted to control the design and placement of structures on the Lake Winnipeg shoreline. The uncontrolled placement of structures is a safety hazard, restricts access and use of the beach and may contribute to erosion on either side of the structure.

3. Demonstration Projects

- The prevention of erosion is a complex issue. It is recommended that three demonstration projects be constructed to demonstrate proper

techniques and to evaluate designs. To be effective, the demonstration projects need to be monitored over at least ten years. It is recommended that a ten-year monitoring program be included as part of the demonstration project.

- The demonstration projects should be selected in consultation with the affected municipalities and First Nation communities around the south basin.

4. Adoption of the Lake Winnipeg Shoreline Protection Handbook

- The handbook should be reviewed by each planning district bordering Lake Winnipeg and formally adopted as the reference standard for design and construction of shoreline structures.

5. Long-Term Commitment to Provision of Advisory Services to Municipalities and Cottage Owners

- A significant problem for property owners, First Nation communities and municipalities is the lack of advice concerning shoreline protection measures. While the "handbook" is an appropriate first reference and guide to good practice, erosion issues are site-specific. Professional advice is a necessary adjunct until local authorities have gained experience in the proper design and construction of shoreline protection structures. It is recommended that a professional advisory service be made available to cottage owners and municipalities for a period of five years. The advice could be in the form of workshops and detailed design services for all interested parties.

6. Reporting on Water Levels

- Water levels should be reported on a daily basis throughout the open water season. Reporting should reflect actual levels and include forecasts of expected levels. Reporting wind-eliminated water levels is of limited value to the public and should only be made available to the public on request.
- When lake water elevations begin to approach either the minimum or maximum as outlined under its interim licence, Manitoba Hydro should conduct an analysis to determine what unusual event or conditions would cause the levels to fall outside of the target range, and to ascertain what action would be required to maintain the levels within the target range.
- An internet web site should be developed to report unadjusted, instantaneous water levels, as well as wind-eliminated water levels, at various locations throughout the south basin.

7. Choosing A Solution

- Based on the technical advice provided, the Advisory Group recommends that wherever practical, nonstructural solutions to erosion problems be adopted. If such solutions are not practical, then structural solutions such as replication of natural processes and working with natural processes should be adopted. The Advisory Group recognizes that solutions which oppose natural forces will be required in specific situations and recommends that such options be carefully designed with professional assistance and constructed giving consideration to the ramifications of doing so.

8. Adopt Consultants' Recommendations

- The Advisory Group recommends that the recommendations of the Baird report with regard to the measurement of lake elevations, the Pollock and Wright report and the Stantec/Baird report regarding shoreline management options be adopted.

Appendix A:

Glossary of Terms

Accretion

A volumetric addition of shoreland by natural deposition.

Artificial Nourishment/ Beach Nourishment

The act of artificially supplying an eroding shoreline with new sediment (usually sand), to replace, enhance or maintain a beach for recreational purposes and shoreline protection.

Average Annual High Water Level

The average of the highest monthly mean level of each year over a period of time.

Average Annual Low Water Level

The average of the lowest monthly mean level of each year over a period of time.

Average Annual Water Level

The average of monthly mean water levels over the year.

Bathymetry

The topography of the lake bottom.

Bluff/ Cliff

A steep slope or bank in either glacial sediment or rock, usually facing the lake.

Contour

A line drawn on a map connecting points of the same elevation.

Current

A flow of water.

Current, Longshore

The current in the breaker zone moving essentially parallel to the shore generated by wave breaking at an angle to the shoreline.

Downdrift

The direction of predominant movement of littoral materials.

Dunes

Ridges or mounds of loose, wind-blown material, usually sand.

Erosion

A volumetric reduction of shoreland by natural processes.

Erosion Rate

The net loss of shorelands normally located above the lake surface elevation over a specific period of time.

Fetch

The distance across the lake which waves are generated by a wind having a generally constant direction and speed.

Groyne

A shoreline protection structure built out at an angle from shore to trap sand and to protect the shore from erosion by currents and waves by making a beach

Groyne Field

A series of groynes acting together to protect a section of shore.

Glacial Till

A sediment which is deposited directly from a glacier, and which exhibits a wide range of particle sizes, from fine clay to rock fragments and boulders.

Inundation

The temporary submergence of shorelands normally located above lake levels.

Jetty

An elongate artificial obstruction projecting into the lake from shore to control shoaling and scour by deflection of currents and waves.

Littoral

Pertaining to or along the shore, particularly to describe currents, deposits and drift.

Littoral Barrier

An object, manmade or natural, that interrupts the natural Longshore transport of littoral drift.

Littoral Drift

Sediment, ranging in particle size from fine sand to coarse gravel that is transported in the littoral zone under the influence of wind generated waves and currents.

Nearshore

An indefinite zone extending lakeward from the average annual water level to beyond the breaker zone defining the area of nearshore currents formed primarily by wave action.

Recession

A landward retreat of the shoreline by shore processes.

Reflection

A wave turned lakeward after striking a shoreline structure or cliff.

Revetment

A facing of stone, concrete etc., built to protect an embankment or shore structure against erosion and failure by wave action or currents.

Riprap

A layer, facing, or protective mound of stones randomly placed to prevent erosion, scour or sloughing of a structure or embankment; also the stone so used.

Rubble

Rough, irregular fragments of broken rock.

Scour

Removal of material by waves and currents, especially at the base or toe of a shore structure or cliff.

Seepage

Water escaping through, or emerging along an extensive line to surface; the slow movement of water through soil by gravity.

Seiche

An oscillatory motion resulting in alternate high and low water levels at each end of the lake that continues after the originating force has ceased.

Setback Requirement

A distance measured, inland from the edge of bluff, where construction is prohibited except for the purpose of erosion or flood control.

Slump

A failure of bluff slope with a mass movement along a failure plane.

Toe Erosion

The erosion which occurs at the toe of bluffs largely as a result of the continuous removal of earthen material by waves and currents.

Undercut

Undermining, erosion of the lower part of a steep bank so as to reduce the stability of the upper part.

Uprush/ Runup

The rush of water up onto the beach or shore following the breaking of a wave;

Wind Setup/ Storm Surge

Wind setup (or storm surge) is the increase in the height of water due to winds pushing water from one end of the lake to the other. There is a corresponding decrease in water levels, or setdown, at the upwind end of the lake.

Wind-Eliminated Water Levels

The lake level when the effects of wind are eliminated; the elevation a water surface would assume if all wave action were absent.

Appendix B:

Lake Winnipeg Shoreline Erosion Advisory Group

- Spring 1999 Newsletter

- Fall 1999 Newsletter



David Farlinger, P. Eng.
Consulting Engineer
Chair

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Reeve Ron Thomas
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John Walker
Real Estate Broker and
Property Owner,
Winnipeg Beach

SPRING • 1999

Who is the Lake Winnipeg Shoreline Erosion Advisory Group?

The Lake Winnipeg Shoreline Advisory Group was established by the Manitoba Government in October 1998 for the purposes of:

- gathering and disseminating information on erosion processes and practical shoreline protection options;
- conducting a third party assessment of the accuracy and integrity of Manitoba Hydro's reporting of Lake Winnipeg water level data and methodology;
- receiving and responding to concerns and questions from the public regarding erosion; and
- advising the Province and stakeholders on matters regarding erosion.

The Group has been established as an independent body. The membership is made up of elected municipal officials from Rural Municipalities bordering the south basin of Lake Winnipeg, Lake Winnipeg property owners and professional engineers with expertise in hydrology and erosion. Names and affiliations of Advisory Group members are listed in this newsletter.

*The Advisory Group reports to the
Minister responsible for the Manitoba Hydro Act and
to the Minister of Natural Resources.*

What will the Advisory Group actually do?

The Advisory Group will obtain professional advice on shoreline erosion and protection and consult with the public about personal experience with shoreline erosion and success or failure of individual shoreline protection measures.

The Advisory Group has no predetermined conclusions about what it will find and/or what it will recommend.

What has been done to date?

The Advisory Group has been meeting internally to finalize a work plan. It has received presentations from Manitoba Hydro, Manitoba Department of Natural Resources and from an independent expert on shoreline erosion. Proposals have been received from independent, out-of-province consultants to conduct a review of the accuracy and integrity of Manitoba Hydro's reporting of Lake Winnipeg water level data and methodology

What has yet to be done?

The Advisory Group has only started its work program. Work yet to be done includes the following:

- hold public meetings to receive information and concerns about shoreline erosion
- assemble data on the magnitude and impact of erosion
- develop options for dealing with shoreline erosion that are technically sound and economically and environmentally acceptable.

What will the Advisory Group produce?

The Advisory Group will produce a report outlining shoreline erosion problems, public concerns about shoreline erosion, possible solutions to shoreline erosion, and recommendations for demonstration projects, publications and workshops. The report is expected in the spring of the year 2000.

Can the Public Participate?

Yes! Public participation is an important part of the overall process. The Advisory Group is looking to the public to inform us about their concerns, experience with individual attempts at shoreline protection, records of shoreline erosion (*including photos*), accounts of severe shoreline erosion events, records of property damage caused by shoreline erosion and financial and other impacts of shoreline erosion.

How will the public consultation process work?

• Public consultation will take place in at least three phases. The first phase will be to gather information from individuals, environmental and property organizations, and municipal government about their experience and concerns with shoreline erosion. The second phase will be to present preliminary findings to the public about what we heard from the public presentations and the information we obtained from our technical advisors. The third phase will present our conclusions and recommendations.

• As part of the first phase, the Advisory Group will be holding information sessions in several south basin communities and in the City of Winnipeg. These sessions will be in a public place. Appointments are recommended to allow presentations to be made in a convenient manner.

The first information session?

We expect the first phase information sessions to be held in early to mid June. Announcements of these sessions will be placed in local newspapers and distributed through our mailing list.

Questions Answers

Q: Will the Advisory Group be looking at Lake Winnipeg water level regulation?

A: The Advisory Group will be retaining professional advisors to conduct a third party assessment of the accuracy and integrity of Manitoba Hydro's reporting of Lake Winnipeg water level data and methodology. Additionally, the Advisory Group will gather, study and disseminate information on erosion processes. The Advisory Group's work will not include a review of Lake Winnipeg Regulation.

Q: Will the Lake Winnipeg Shoreline Advisory Group be implementing shoreline protection measures?

A: The Advisory Group will produce a report that outlines the magnitude of the shoreline erosion problem in the south basin of Lake Winnipeg and makes recommendations for possible solutions and for possible demonstration projects.

Q: Will the Advisory Group be looking at erosion over the entire lake?

A: At this time the Advisory Group will be looking at erosion affected areas primarily in the south basin of Lake Winnipeg.

Q: How can the public see the information that has been collected?

A: The Advisory group will maintain a comprehensive file of information at all municipal offices in the south basin and at our head office. As soon as information is available at these sites we will advise you by letter and/or notice in the newspaper. We may also develop a web site that will include information about up-coming meetings and most of the data that we have been collecting.

Q: Where can we get more information?

A: Write or phone the address on the back of this newsletter.

Q: Who is on the mailing list?

A: Municipal offices and towns bordering the south basin, cottage owners associations and anyone who has expressed an interest in our work is on the mailing list. If you know anyone who would like to be on the mailing list please write to us or call the phone number on the back of this newsletter.

Q: Will you have a web site?

A: We are considering developing a web site and will make a public announcement if we proceed.

Map & Glossary of Terms

South Basin of Lake Winnipeg

For the purposes of the Lake Winnipeg Shoreline Erosion Advisory Group the South Basin of Lake Winnipeg is that part of the lake south of Lake Winnipeg narrows.

Shoreline erosion

The wearing away of land and the carrying away of beach material by wave action and littoral currents

Accretion

The build up of land and the deposition of waterborne material by wave action and littoral currents.

¹ The glossary section of each newsletter will contain technical definitions of terms as they appear in newsletters from time to time.

Lake Winnipeg Shoreline



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Newsletter

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Helen Trainor
Real Estate Broker and
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Victoria Beach

This is newsletter #2 of the Lake Winnipeg Shoreline Erosion Advisory Group. This newsletter is part of the public consultation process - keeping people informed about the work of the Advisory Group.

What has the Advisory Group accomplished?

The Advisory Group has been obtaining professional advice on shoreline erosion and protection measures and has started to consult with the public about issues, experience and concerns with shoreline erosion. Activities include the following:

Meetings: Public meetings were held in seven south basin communities during the month of June. The purpose of the meetings was to receive information on issues, experiences and concerns with shoreline erosion. Meetings were held in Gimli, Riverton, Selkirk, Victoria Beach, Scantbury, Grand Marais and Winnipeg.

Tours: The Advisory Group toured the south basin of Lake Winnipeg. The purpose of the tour was to observe the impact of erosion at some of the worst impacted sites in the south basin and to look at shoreline protection measures that individuals and municipalities have put into place.

Studies: The Advisory Group has commissioned a number of studies, presentations and reviews. Most of these are in progress and will not be complete until the end of the year.

✦ **Kamphuis Lecture** - A lecture presented by Dr. J. William Kamphuis, Queen's University, to the Advisory Group. The lecture encompassed the erosion process and shoreline protection.

✦ **Manitoba Natural Resources and Manitoba Hydro** - Manitoba Hydro and Manitoba Natural Resources made independent presentations to the Advisory Group.

✦ **Methodology Review** - A contract was awarded in August to Baird & Associates to review "Manitoba Hydro's Methodology for Determining and Reporting Lake Winnipeg Water Levels as well as the Accuracy and Integrity of such Water Level Data and Reporting". Baird & Associates are an independent engineering consulting firm based in Ottawa.

*Continued
from Page 1*

- A Legislative Review - Legislation applicable to Lake Winnipeg and dealing with water resources, land use and natural resource management is currently being assembled. Once assembled the Advisory Group proposes to obtain a legal opinion on issues related to shoreline ownership, who (if anyone) has responsibility for shoreline protection and who has a responsibility to approve and oversee shoreline protection measures.
- A Measuring Shoreline Erosion - A study has been commissioned to measure shoreline erosion from aerial photography. The study will focus initially on one shoreline section on each side of the lake. If that proves successful the study will be extended.
- A Shoreline Protection - Proposals have been received and a contract awarded to Stantec Consulting Ltd. to undertake a study of practical shoreline protection options. The purpose of the study is to carry out functional level designs for different shoreline characteristics and to prepare a design manual.

What Have We Heard From The Public?

Our principal source of information has been from meetings. While there were many issues raised in public meetings, some of the common themes included the following:

- A Shoreline erosion is a serious problem for many property owners and other people concerned about beaches, marshes and environmental quality of the lake. Presenters were mostly of the opinion that the rate of erosion and the amounts of damage are increasing.
- A Many presenters expressed a high level of frustration about lack of advice on appropriate shoreline protection measures, uncertainty about ownership of the beach area, lack of regulations and approvals for individual shoreline protection measures and an apparent lack of response, concern and interest from all levels of government and Manitoba Hydro.
- A There was frequent comment that the worst erosion was being caused by a combination of high water levels and high winds, particularly in the fall. Some information was received about shoreline protection measures that have proven successful over the years.



*An example of the problems
caused by erosion.*

Public Meetings



Residents and Advisory Group members look over plans at the Selkirk meeting.



Ken Danwich and a local resident at the Victoria Beach meeting.

In Riverton, Cliff Evans (Former MLA for the Interlake), David Farlinger (Chair of LWSEAG), and Nelson Gerrard (Lake Winnipeg Watch) discuss issues.



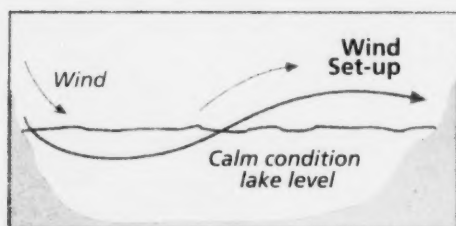
What is the next step?

The work of the Lake Winnipeg Shoreline Erosion Advisory Group is an ongoing process. When all of the studies and reviews are complete there will be further public meetings to present information obtained at our first meetings and information obtained from our professional advisors.

Is it too late to participate?

No. The Advisory Group would be pleased to hear from you about your concerns, experiences and success stories with shoreline erosion. Please contact us at the address shown at the bottom of the last page.

Glossary of Terms



Wind Set-Up/Set-Down

Wind set-up (or storm surge) is the increase in the height of water due to winds pushing water from one end of the lake to the other. There is a corresponding decrease in water levels, or set-down, at the up-wind end of the lake. As the result of strong and persistent winds, wind set-up of over 3.7 feet has been observed in the south basin.

Seiche

Seiche is the "sloshing" effect of a waterbody after a wind set-up event. The water level oscillates around the lake until it settles to its undisturbed level. These oscillations of the lake level take some 39 hours when the wind set-up is from north to south.



Groyne

A groyne is a man made structure built on the shoreline and extending perpendicular to the shoreline into the water. The purpose of the groyne is to trap sand and provide shoreline protection. Observations suggest that groynes may trap sand on one side of the groyne and cause erosion on the other. The success of groynes at trapping sand varies from site to site and the ability of groynes to prevent shoreline erosion is inconclusive.

Lake Winnipeg Shoreline



For further information
please contact us at:

Unit #1 - 117 Victor Lewis Drive

Winnipeg, Manitoba
R3P 1J6

Telephone:
(204) 982-3567

Fax:
(204) 982-3565

E-mail:
lwag@mb.aibn.com

The Lake Winnipeg Shoreline Erosion Advisory Group was established by the Manitoba Government for the purposes of:

- gathering and disseminating information on erosion processes and practical shoreline protection options;
- conducting a third party assessment of the accuracy and integrity of Manitoba Hydro's reporting of Lake Winnipeg water level data and methodology;
- receiving and responding to concerns and questions from the public regarding erosion; and
- advising the Province and stakeholders on matters regarding erosion.

The Group has been established as an independent body. The membership is made up of elected municipal officials from Rural Municipalities bordering the south basin of Lake Winnipeg, Lake Winnipeg property owners and professional engineers with expertise in hydrology and erosion. Names and affiliations of Advisory Group members are listed in this newsletter.

The Advisory Group reports to the Minister responsible for the Manitoba Hydro Act and to the Minister of Conservation.

Appendix C:

*Responses to questions raised by the
Lake Winnipeg Shoreline Erosion Advisory Group by:*

*Baird and Associates,
Manitoba Water Resources
and Manitoba Hydro*

(Colour versions of these responses are available
from the Lake Winnipeg Shoreline
Erosion Advisory Group)



April 25, 2000

Mr. David Farlinger, Chair
Lake Winnipeg Shoreline Erosion Advisory Group
1-117 Victor Lewis Drive
Winnipeg, Manitoba R3P 1J6

W.F. Baird & Associates
Coastal Engineers Ltd.
1145 Hunt Club Road, Suite 1
Ottawa, Ontario, Canada K1V 0Y3
Telephone 613 731-8900
Fax 613 731-9778
Web Site www.baird.com

Dear David:

Re: Lake Winnipeg Water Level Study

We have investigated the various questions raised by the Lake Winnipeg Shoreline Erosion Advisory Group as outlined in your recent memorandum. The questions, and our responses to them, follow:

1a. Using a common methodology, what is the long-term average level of Lake Winnipeg pre- and post-regulation? For purposes herein, pre-regulation is pre-1972 and post-regulation is post-1976. The period 1972-76 has been excluded because the levels in this period may have been influenced by the construction of infrastructure at the north end of the lake.

The long-term average water level at Beren's River, as derived from monthly water level data provided by the Water Survey of Canada, is 713.22 ft LWD from 1914 to 1971, inclusive, and 713.27 ft LWD from 1977 to 1995. A monthly average water level at Beren's River would be indicative of a wind-eliminated monthly water level on Lake Winnipeg.

For comparative purposes, the long-term average level on Lake Winnipeg, as derived from the wind-eliminated water level data provided by Manitoba Hydro, is 713.23 ft LWD from 1914 to 1971, inclusive, and 713.31 ft LWD from 1977 to 1995.

We note that the merits of excluding any or all of the time period from 1972 to 1976 from the water level averages, due to the possible influence of the construction of infrastructure, depends largely on the details of the construction process. The nature and schedule of construction activities would have to be reviewed in context of the impact of these activities on the lake water levels.

We also note that comparisons of average water levels from the pre- and post-regulation periods on Lake Winnipeg should be carefully interpreted. There are 58+ years of water

Mr. David Farlinger

April 25, 2000

Page 2

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Baird

level data prior to regulation (to 1971) and 19 years of data from 1977 to 1995. Rainfall over the Lake Winnipeg catchment area varies with long-term (decadal and longer) climatic cycles. As shown in Table 3.1 of our final report, the average water level over any twenty-year period during the pre-regulation period can vary in the order of 2 feet.

1b. Using a common methodology, what is the long-term average level pre- and post-regulation (excluding 1972-1976) for the fall months? Fall is defined as the months of September, October and November.

The long-term average water level for the fall months at Beren's River, as derived from monthly water level data provided by the Water Survey of Canada, is 713.37 ft LWD from 1914 to 1971, inclusive, and 713.43 ft LWD from 1977 to 1995.

1c. Has the method of measurement changed in the pre- and post-regulatory period, and would this result in any change in the reported lake levels. Has the type of water level reporting to the public (i.e. wind-eliminated or actual) changed in the pre- and post-regulation period?

There have been various changes to the water level measurement methodology over the 85+ years of water level measurement on Lake Winnipeg. Most of the measurements up until approximately 1958 were based on manual measurements of water level carried out once per day. Since then, self-recording gauges have been installed, providing near-continuous measurements of water level during the operational periods.

The type of water level reported to the public has changed in the pre- and post-regulation period as the present methodology for mathematical derivation of the wind-eliminated water level was not adopted until the release of the December 1982 Report on Lake Winnipeg Levels prepared by the Ad Hoc Committee. It is our understanding that prior to 1982 the wind-eliminated water levels were estimated from water level recordings taken during calm periods on the lake.

Mr. David Farlinger
April 25, 2000
Page 3

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Baird
Id. Is the average water level at the extreme north end of the north basin different pre- and post-regulation (excluding 1972 to 1976)? Has the slope of the water surface changed in the north basin as a consequence of regulation?

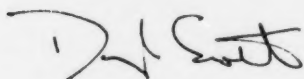
The most northerly gauge, Montreal Point, has only been operational since 1969 so there is very little data in the pre-regulation period. The next most northerly gauge, Mission Point, has operated since 1953. The average water level at Mission Point from 1953 to 1971 was 714.65 ft LWD while the average water level over the post-regulation period from 1977 to 1995 was 713.26 ft LWD. The 1950's to the 1970's was a period of relatively high water levels on Lake Winnipeg.

The water surface in the north basin has a near-negligible slope. This was shown in one of the hydraulic model simulations carried out for the water level study in which the water level at Montreal Point was held fixed and all of the inflows to Lake Winnipeg permitted to discharge at their mean June flow rates. This model simulation showed a total water level variation over the length of Lake Winnipeg of 0.016 m (0.05 feet). Most of the variation occurred in the south basin and through the Narrows.

I trust that the above will meet your requirements. Please do not hesitate to contact me, should you require further information.

Yours truly,

W.F. Baird & Associates Coastal Engineers Ltd.



R. Douglas Scott, Ph.D., P.Eng.
Principal

File No. 10130





Water Resources Branch
Box 14, 200 Saulteaux Crescent
Winnipeg MB R3J 3W3

April 10, 2000

File: 31.1.7

Mr. David Farlinger
Chair
Lake Winnipeg Erosion Advisory Committee
2100 McGillivray Blvd.
Winnipeg MB R3Y 1N3

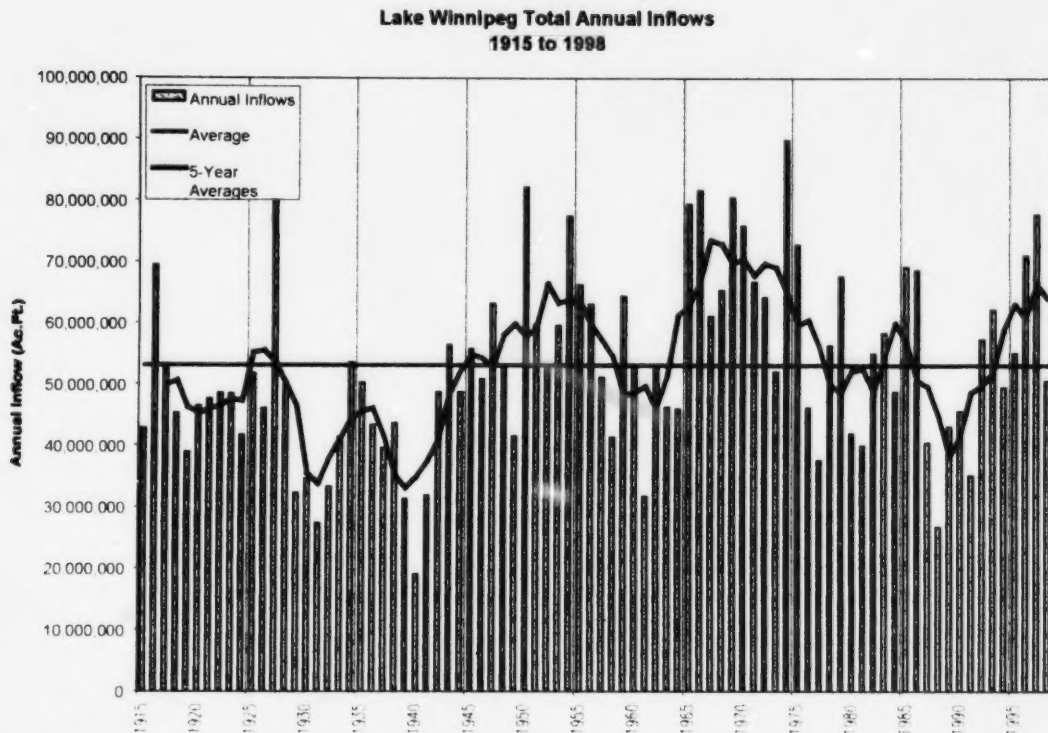
Dear Mr. Farlinger:

In response to your request of March 8, 2000 I have analyzed the recorded data for Lake Winnipeg to provide answers to question number 2 raised by the Lake Winnipeg Shoreline Erosion Advisory Group.

2(a) *Have the precipitation and inflows in the catchment area been greater than average since 1992?*

The following figure shows annual inflows to Lake Winnipeg for the period 1915 to 1998. The annual flows from 1959 to the present were computer by adding the total outflow from the lake to the annual change in storage in the lake. As a comparison I summed the flows for all of the rivers flowing into the lake that have flow records. The results were very similar, but consistently lower, because of the ungauged tributaries.

There is insufficient recorded flow data before 1959 to accurately compute inflows using the method described above. I therefore used a series of water level versus outflow relationships developed by Water Survey of Canada in 1969 for the lake under unregulated conditions. I applied these relationships to the recorded average monthly levels to compute average monthly outflows and total annual outflows. I again added the annual changes in storage on the lake to the computed annual outflows to provide estimated annual inflows. These curves for computing unregulated outflows are recognized to be imprecise. The historic relationship between Lake Winnipeg levels and outflows was variable because of factors like weed growth in Playgreen Lake. However the computed annual averages should still be reasonably accurate, because the relationships were developed based on a best fit of the full data record.

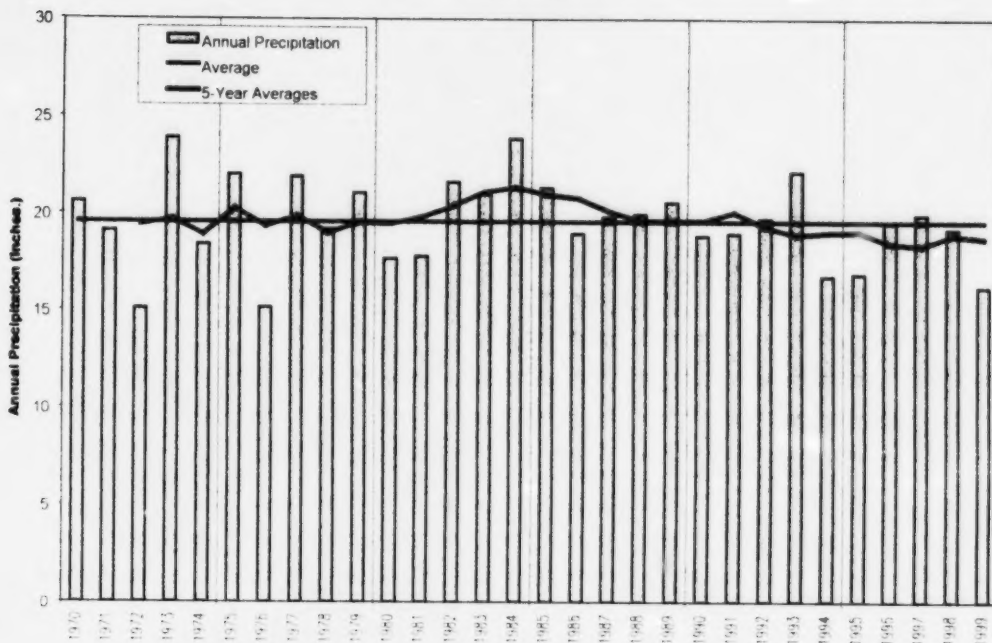


This plot shows the annual inflow volumes as well as the 5-year moving averages. The moving average trace shows the multi-year trends in inflows. It shows that inflows were above average during the 50's, during the mid 60's to mid 70's, and for the last few years.

Specifically, since 1992 the average inflow has been 60.5 million acre-feet, or 14% above the long term average.

The next chart shows total annual precipitation over Lake Winnipeg from 1970 to the present. Again the chart shows the annual totals plus the 5-year moving averages. Interestingly these precipitation totals are less variable than the total inflows. Also for the period from 1992 to 1999 precipitation over the lake has been slightly below average. Therefore the fluctuations of the lake levels over this period are more a reflection of inflows from the total million square kilometre drainage area, rather than from precipitation over the lake surface.

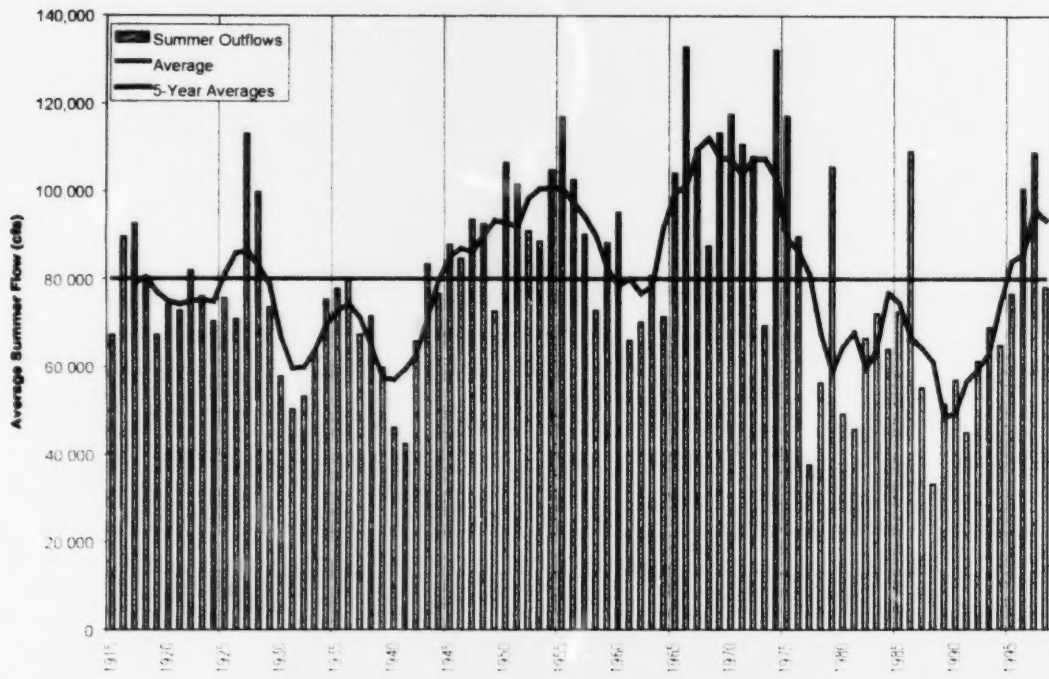
**Lake Winnipeg Total Annual Precipitation
1970 to 1999**



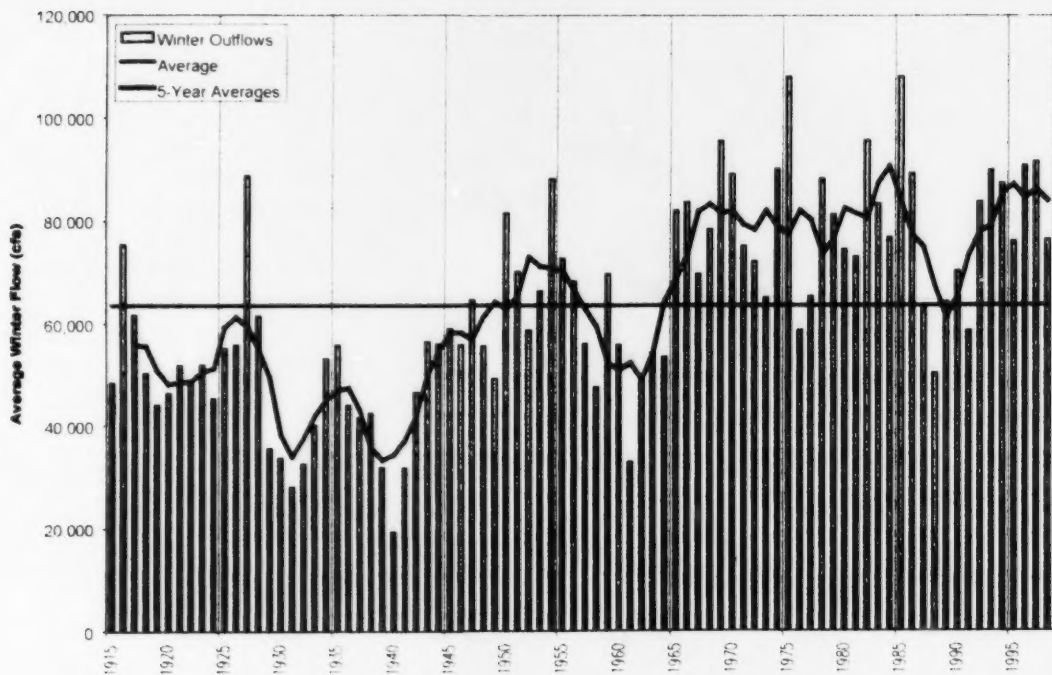
2(b) *Have the summer and winter outflows from Lake Winnipeg been significantly different since 1992?*

The next two figures show average summer and winter outflows from Lake Winnipeg for the period 1915 to 1998. The summer flows are the average flows for the months from April to October. The winter flows are the average flows from November to March of the following year. The pattern for summer outflows is very similar to the pattern for total annual inflows. The pattern for winter outflows shows a change in pattern in the mid 70's. Since regulation the outflows have been above the long term average in all but three years. This reflects the increased outflow capacity of the lake. Before regulation the winter flows averaged 70 % of the summer flow rates. Since 1976 the ratio has increased to 87% of the average summer flow rate.

**Lake Winnipeg Annual Summer Outflows
1915 to 1998**



**Lake Winnipeg Annual Winter Outflows
1915 to 1998**



For the period from 1992 to the present summer outflows have averaged 80,000 cfs, which is about equal to the long term average. Winter outflows have averaged 85,200 cfs, which is 34% above the long term average.

The figure also shows a difference in both summer and winter outflows between the early regulation years (1976 to 1991) and the more recent period (1992 to 1998). For the summer period average outflows from 1992 to 1998 were 26% higher than the average for the early regulation period. The winter flows for the recent period are 13% higher than for the earlier regulation period.

2(c) *Using suitable data (over-water wind events) has there been an unusual (greater than average) combination of high water and high winds since 1992?*

Wind setup at the south end of Lake Winnipeg occurs when a sustained northerly wind forces water from the north basin of Lake Winnipeg into the south basin. Wind data for Lake Winnipeg, particularly over water wind data, is sparse. However a comparison between recorded lake levels and smoothed lake levels clearly shows the wind setup events on the south basin. Therefore an analysis was done of daily wind setups at the Gimli hydrometric station 05SG006 from 1974 to 1999. Wind setup events for the 18-year period from 1974 to 1991 were compared to wind setups for the period from 1992 to 1999 to see if there has been an unusually high number of wind setup events. The results are shown in the following table:

Number of Occurrences of Wind Setup on Lake Winnipeg

Lake Levels:	Daily Average Wind Setup at Gimli (ft.)		
	2 – 2.5 ft.	2.5 – 3 ft.	> 3 ft.
1974 – 1991			
<713.5 ft.	3	3	0
713.5 – 714 ft.	2	0	0
714 – 714.5 ft.	0	0	0
714.5 – 715 ft.	0	0	0
>715 ft.	0	0	0
1992 – 1999			
<713.5 ft.	1	0	1
713.5 – 714 ft.	2	0	0
714 – 714.5 ft.	2	1	1
714.5 – 715 ft.	0	0	0
>715 ft.	0	0	0

The results do show an increase in the severity of wind setup events in the later period. During the 18-year period from 1974 to 1991 there were eight major wind setup events. The eight-year period from 1992 to 1999 also had eight major wind setup events, representing a more than doubling in the frequency of occurrence. Also the table shows that in the later period more wind setup events happened during periods with higher lake levels. From 1974 to 1991 no wind setups greater than 2.5 feet occurred when lake levels were above 713.5 feet. During the period from 1992 to 1999 two wind setups greater than 2.5 feet occurred when lake levels were above 714 feet.

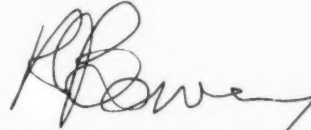
2(d) *Were the precipitation and inflows in the catchment area greater than average for the period 1972 - 76 inclusive?*

Over the five-year period from 1972 to 1976 the inflows to Lake Winnipeg averaged 65 million acre feet, or 22% higher than the long term average inflow. This is close to the highest five-year average over the period of record.

You had also asked during a previous discussion about the validity of the assumption that in the absence of wind or air pressure differences the lake surface would be flat. It is recognized that flowing water slopes down-hill because of the natural resistance in the flow channel. I applied the widely used Manning's equation to the surface of Lake Winnipeg assuming an inflow to the south basin of 150,000 cfs. The results are shown in the attached graph. The computation shows that for a flow of this magnitude the total drop in water surface over the full length of the lake would be just over one hundredth of a foot, or approximately the thickness of two quarters. It is therefore reasonable to assume that in the absence of wind or air pressure differences the lake would be essentially flat.

I trust this information will be useful to your committee. If you require any clarification or further analysis please contact me.

Yours truly,

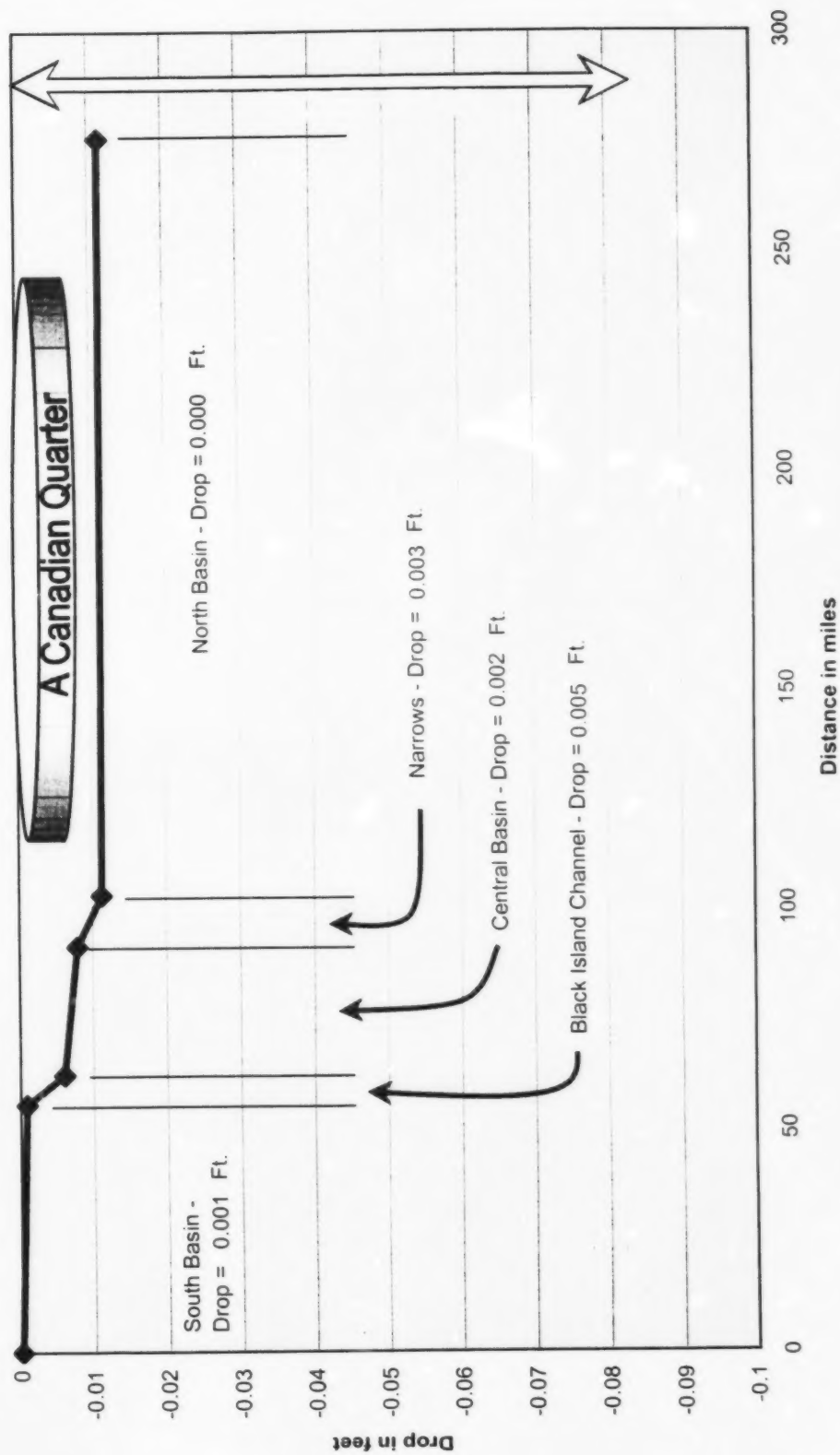
A handwritten signature in dark ink, appearing to read 'R.J. Bowering', with a long horizontal stroke extending to the right.

R.J. Bowering, P. Eng.
Manager
Surface Water Management

RJB rjb

cc. Steve Topping
Attachment

Effect of Flow Rate on Lake Winnipeg Surface Slope Flow of 150,000 cfs



MANITOBA HYDRO

R.B. BRENNAN, C.A.
PRESIDENT & CHIEF EXECUTIVE OFFICER

P.O. BOX 815, WINNIPEG, MANITOBA, CANADA R3C 2P4
TELEPHONE: (204) 474-3600
FAX: (204) 474-4114

2000 02 25

Lake Winnipeg Shoreline Erosion Advisory Group
Attention: Mr. Dave Farlinger, P.Eng.
#1 - 117 Victor Lewis Drive
Winnipeg, Manitoba
R3P 1J6

Dear Mr.  Farlinger:

Re: Lake Winnipeg Shoreline Erosion Advisory Group Steering Committee

The attached response provides answers to the questions included in your 2000 02 10 memorandum.

A number of the questions request calculation of long-term average levels on Lake Winnipeg excluding data for 1972 to 1976 on the grounds that levels in this period may have been affected by construction activities associated with the Lake Winnipeg Regulation project. While answers to these questions have been provided, we do not consider them to be valid. This period was one of the wettest five-year periods and includes the largest single inflow year since 1915. Lake levels were well above the long-term average during this period because inflows were well above average. Excluding such a significant hydrologic period simply misrepresents historical data. Moreover, construction activities in this period would not have had significant effects on Lake Winnipeg levels in comparison to these hydrologic conditions.

Yours truly,



RBB/lf

Att.

c: Mr. N.B. Brandson, Deputy Minister, Dept. of Conservation
Mr. O. Boulette, Deputy Minister, Dept. of Aboriginal and Northern Affairs

Lake Winnipeg Shoreline Advisory Group Questions
February 10, 2000

- 1 *The public believes that Hydro has maintained water levels "artificially" high and that these water levels, particularly in the fall have been the principal cause of accelerated shoreline erosion. This raises the following questions.*
- 1 a) *Using a common methodology, what is the long term average level of Lake Winnipeg Pre and Post regulation? For purposes herein, pre-regulation is pre 1972 and post regulation is post 1976. The period from 1972-76 has been excluded because the levels in this period may have been influence by the construction of infrastructure at the north end of the lake.*
- 1 b) *Using a common methodology, what is the long-term average lake level pre & post regulation (excluding 1972-76) for the fall months*

The period from 1972 to 1976 is one of the wettest five-year periods since 1915 and includes the largest inflow year on record since 1915, as shown in Figure 1, "Lake Winnipeg Average Inflow". It is not valid to exclude such a significant period from historic calculations. Water levels were well above the long-term average during this period because inflows were well above average. Excluding such a significant hydrologic period provides a misrepresentation of historical data.

Though construction activities for Lake Winnipeg Regulation Project were carried out from 1973 to 1976, the effects on Lake Winnipeg water level were not significant in comparison to the effects of hydrologic conditions. Functional regulation of Lake Winnipeg outflow did not commence until July 1976.

The period from May 1913 to June 1976 has a long-term average of 713.4 feet. For the period excluding data for 1972 to 1976 (ie May 1913 to Dec 1971), the long-term average is 713.2 feet, a difference of 0.2 feet. The period from July 1976 to Jan 2000 has a long-term average of 713.4 feet. Excluding data for 1976 (ie Jan 1977 to Jan 2000) results in the same average of 713.4 feet.

For fall months, September to November, the period from 1913 to 1975 has a long-term average of 713.5 feet. For the period excluding date for 1972 to 1975 (ie 1913 to 1971) the long-term average is 713.4 feet, a difference of 0.1 feet. For fall months, September to November, the period from 1976 to 1999 has a long-term average of 713.5 feet. Excluding data for 1976 (ie 1977 to 1999) results in the same long-term average of 713.5 feet.

Figure 2 a shows average daily water levels and ranges of average daily water levels for the period from January 01, 1915 to January 31, 2000 including data for 1972 to 1976. Figure 2 b shows average daily water levels and ranges of average daily water levels for the period from January 01, 1915 to January 31, 2000 excluding data for 1972 to 1976. These figures demonstrate that excluding the hydrologically wet period from 1972 to 1976 does not significantly change average daily water levels.

- 1 c) *Has the method of measurement changed in the pre & post regulatory period and would this result in any change in reported lake levels? Has the type of water level reporting to the public (ie wind eliminated or actual) changed in the north basin as a consequence of regulation?*

Prior to implementation of recommendations from the Adhoc Committee on Lake Winnipeg Datum Report dated December, 1982, average levels were determined by the Provincial Water Resources Branch based on an interpretation of chart data. Wind-eliminated levels calculated using the mathematical procedure recommended by the Adhoc Committee are not materially different from levels determined using the original Water Resource Branch process. Manitoba Hydro uses the recommended mathematical procedure to calculate wind-eliminated levels.

- 1 d) *Is the average water level at the extreme north end of the north basin different pre & post regulation (excluding 1972-76)? Has the slope of the water surface changed in the north basin as a consequence of regulation?*

The Baird & Associates draft report "Review of Lake Winnipeg Water Level Reporting Procedures" dated January, 2000 indicates "that tributary inflows into the lake will cause only very minor fluctuations in the water level. In fact, most of these variations are less than the accuracy of most water level gauges." Under high river discharges, their model calculates a head difference from Pine Falls tailrace (south basin) to Montreal Point (north basin) in the order of 0.016 m (5/8th of an inch).

- 1 e) *Would a lower lake level influence erosion? What would the effects be over time?*

Wind and wave energy are the primary drivers of erosion. Water level is only one of the many secondary factors that can influence erosion, including soil type, exposure, shore slope, vegetation, man-made structures, and soil saturation above water line among others.

- 1 f) *Does maintaining the lake level constantly at its historic average have a more of a negative effect on shoreline erosion than the cumulative effect of varying lake levels in its natural range.*

As shown on the Figure 3, Lake Winnipeg Monthly Mean Levels, the lake is not maintained at any given elevation, rather water levels continue to fluctuate as they did prior to regulation.

- 2 *Shoreline erosion is perceived to be occurring at a faster rate, particularly from 1992 to the present, during which time the public perceives regulation of the lake to be more aggressive.*

- 2 a) *Has precipitation and inflows in the catchment area been greater than average since 1992?*

The average water level in the period 1992 to 1998 was indeed above the long term average.

This was a very wet period with the following significant hydrologic events:

- 1992 Winnipeg River Fall Flood – highest fall flows on record since 1907;
- 1993 summer rains that created a fall flood on the Red River and high flows on the Saskatchewan River and local tributaries;
- 1995 Assiniboine River Spring Flood;
- 1996 Red River Spring Flood;
- 1996/97 Winnipeg River Winter Flood – second highest on record since 1907;
- 1997 Winnipeg River Spring Flood; and
- 1997 Red River Flood of the Century.

Inflows from 1992-1998 were higher than the average of the preceding period from 1976-1991 and were among the highest experienced since 1915. (Figures 1 & 4, Lake Winnipeg Average Inflow)

- 2 *Have the summer and winter outflows from Lake Winnipeg been significantly different since 1992?*

Outflow from May to Oct, 1992-1998 were higher than the average of the preceding period from 1976-1991. (Figure 5, Lake Winnipeg Average Outflow – Open Water)

Outflow from Nov to May, 1992-1998 were higher than the average of the preceding period from 1976-1991. (Figure, 6 Lake Winnipeg Average Outflow - Winter)

- 2 *Using suitable data (over-wind water events) has there been an unusual (greater than average combination of high water and high winds since 1992?*

Three of the top ten largest wind setup events since 1915 occurred from 1993 to 1997 as shown in Figure 7, Maximum Annual Wind Setup Events and Table 1, Maximum Annual Wind Setup Events.

- 3 *Hydro has expressed concern over the prospect of any change in regulated levels of Lake Winnipeg, indicating that any reduction in the upper limit would cost Manitobans huge amounts of money. What are the details of these costs and how are they arrived at?*

The majority of the benefit from using the 1 foot range between 714 and 715 feet is derived from increased dependable energy (firm energy corresponding to the lowest flow on record). Increased dependable energy means that Manitoba Hydro will be able to delay the installation of new generating resources and/or secure higher valued long-term export sales.

The total cost associated with losing the upper one foot of the range is approximately \$300 million (in 1999 dollars). This estimated cost to Manitoba power consumers includes system development and operating costs as well as costs to mitigate flooding impacts on downstream communities.

- 4 *Has the pattern of erosion of the Lake Winnipeg Ridge altered since 1972? If so, how? Has this changed the open water area of Netley Marsh?*

Based on information presented by Geological Survey of Canada geologists, the historic average rate of southward transgression of Lake Winnipeg is between 22 and 25 feet per year. There is no indication that current rates are any different or that processes changed after 1972.

Lake Winnipeg Average Inflow

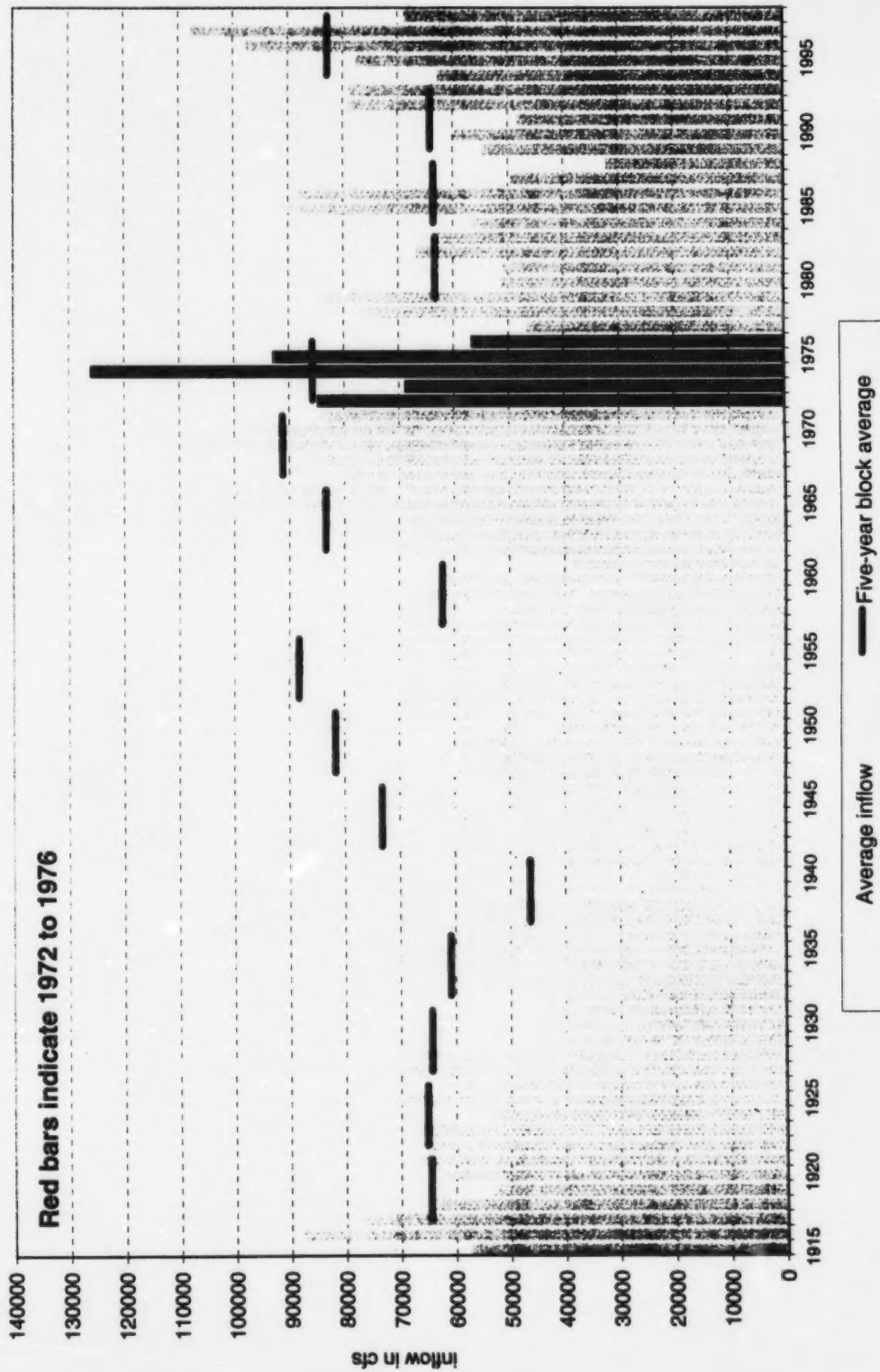


Figure 1

Lake Winnipeg Wind Eliminated Water Level

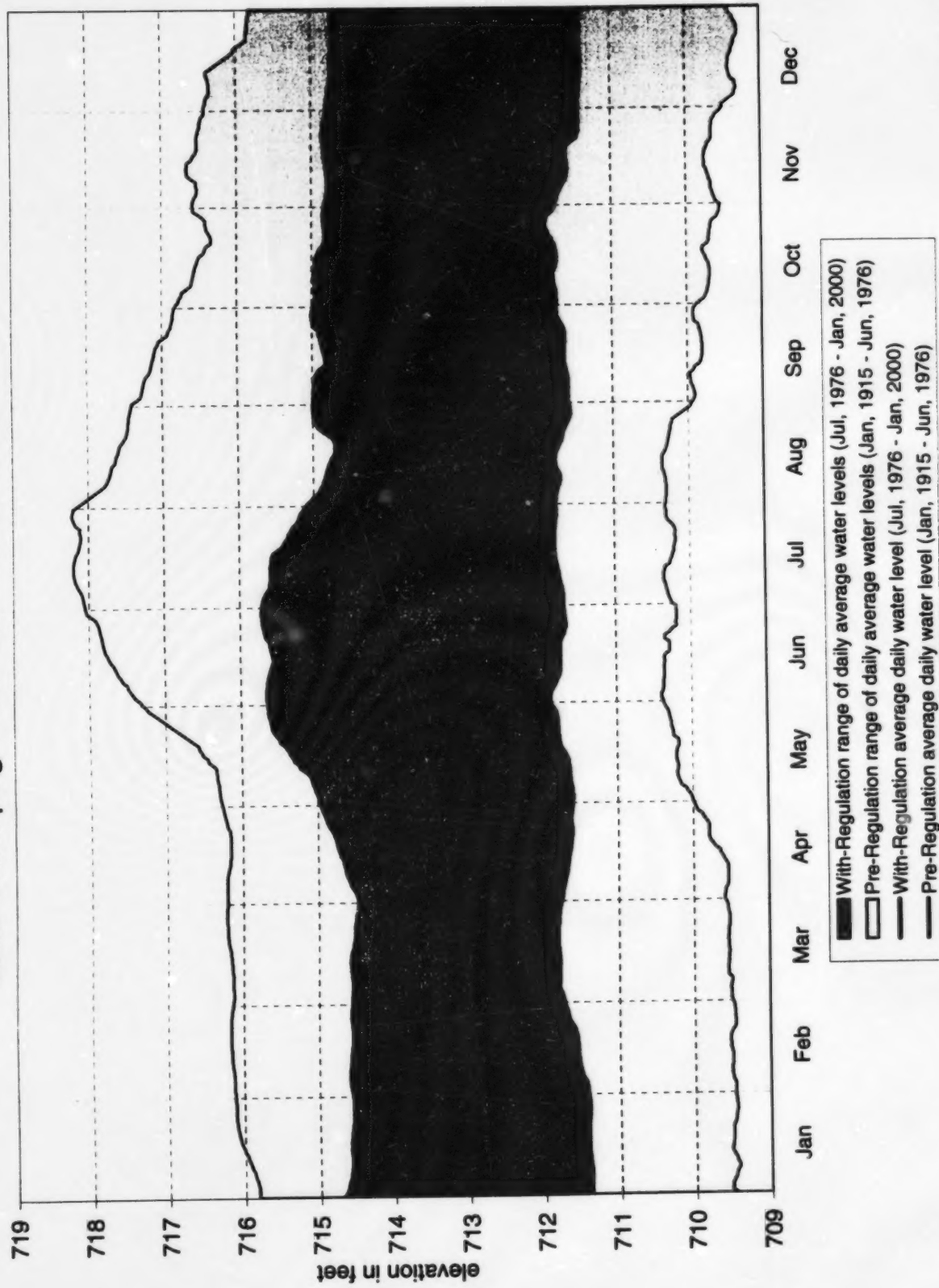


Figure 2 a

Lake Winnipeg Wind Eliminated Water Level

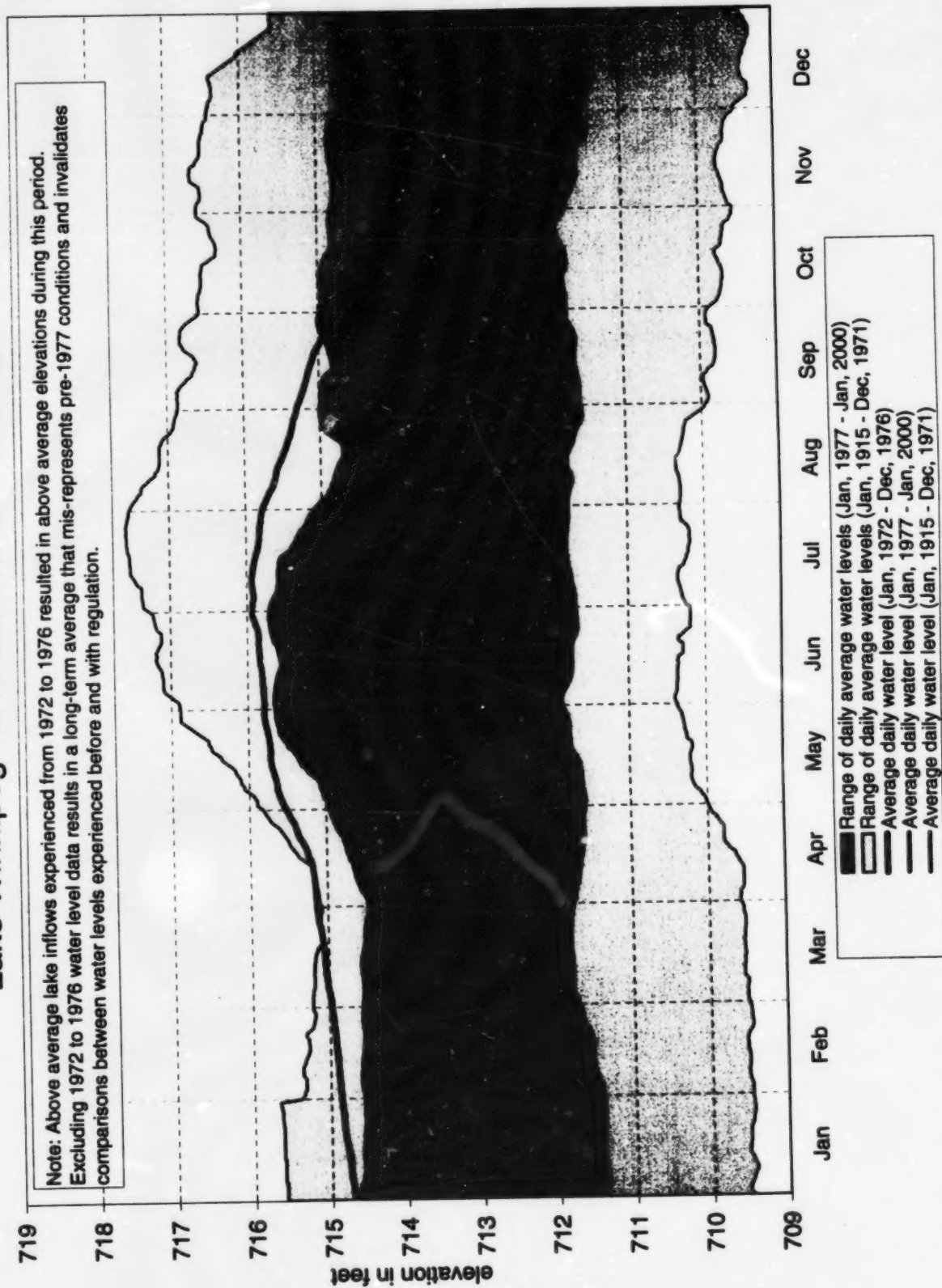
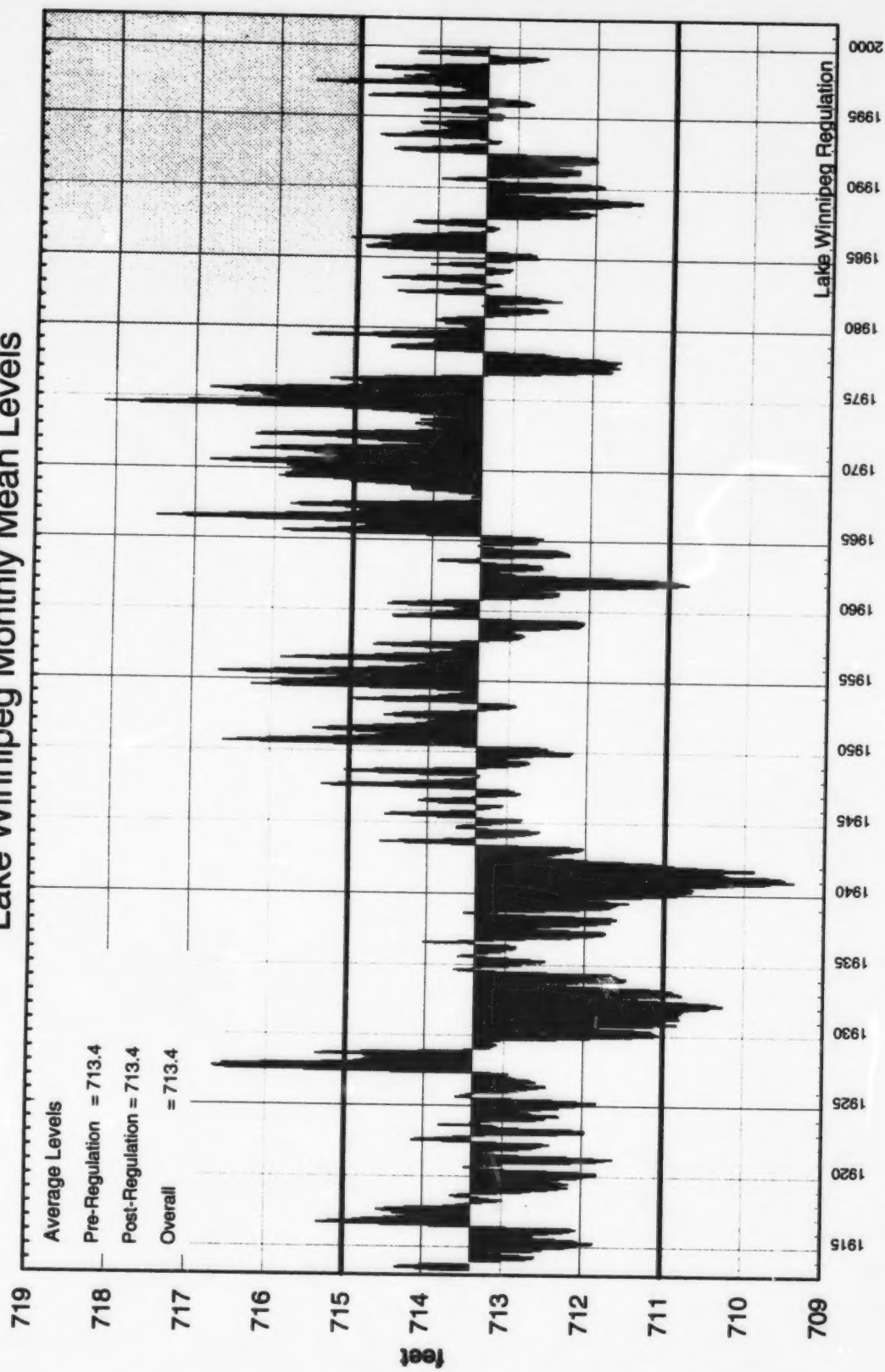


Figure 2 b

Lake Winnipeg Monthly Mean Levels



Lake Winnipeg Average Inflow

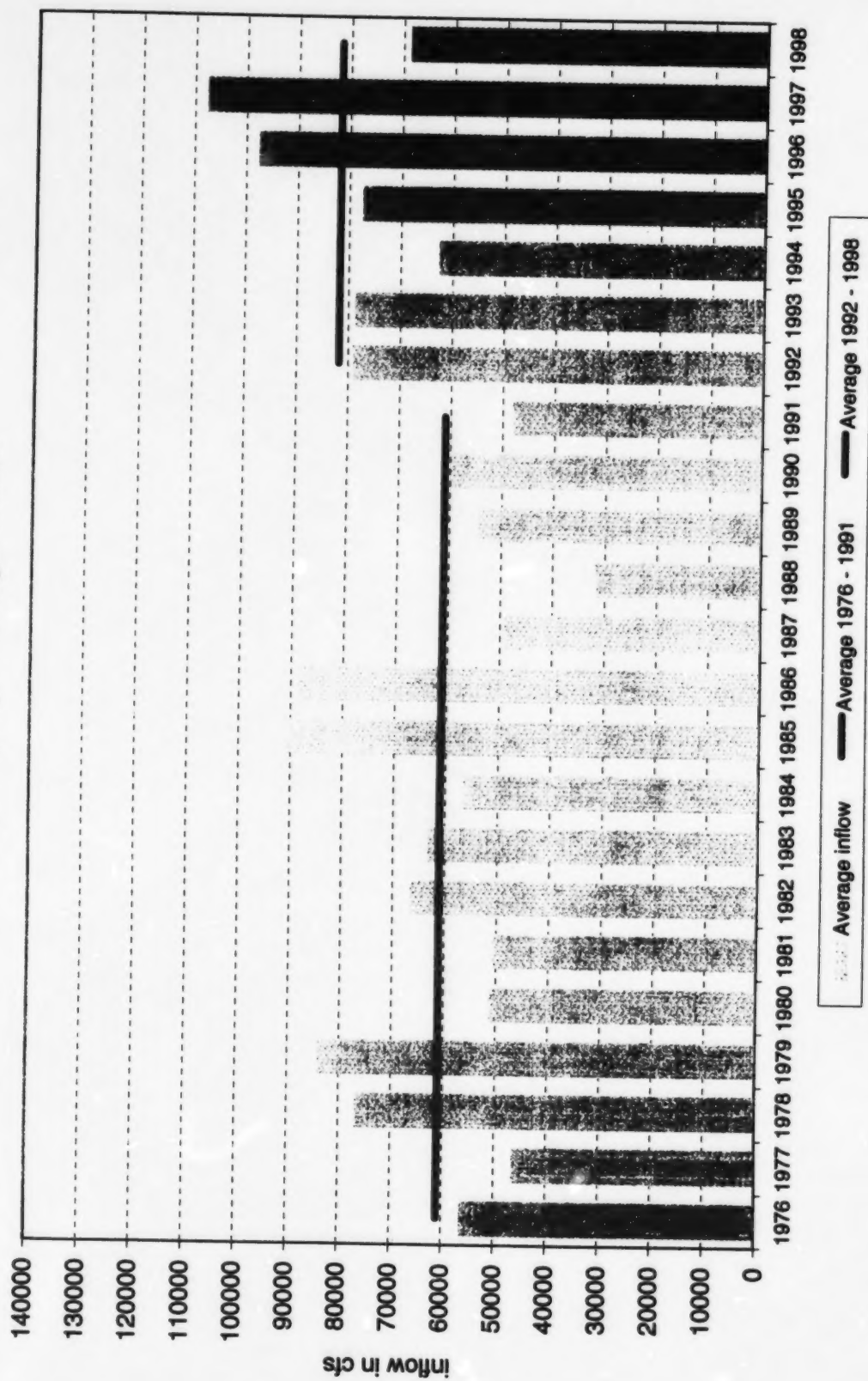


Figure 4

Lake Winnipeg Average Outflow - Open Water

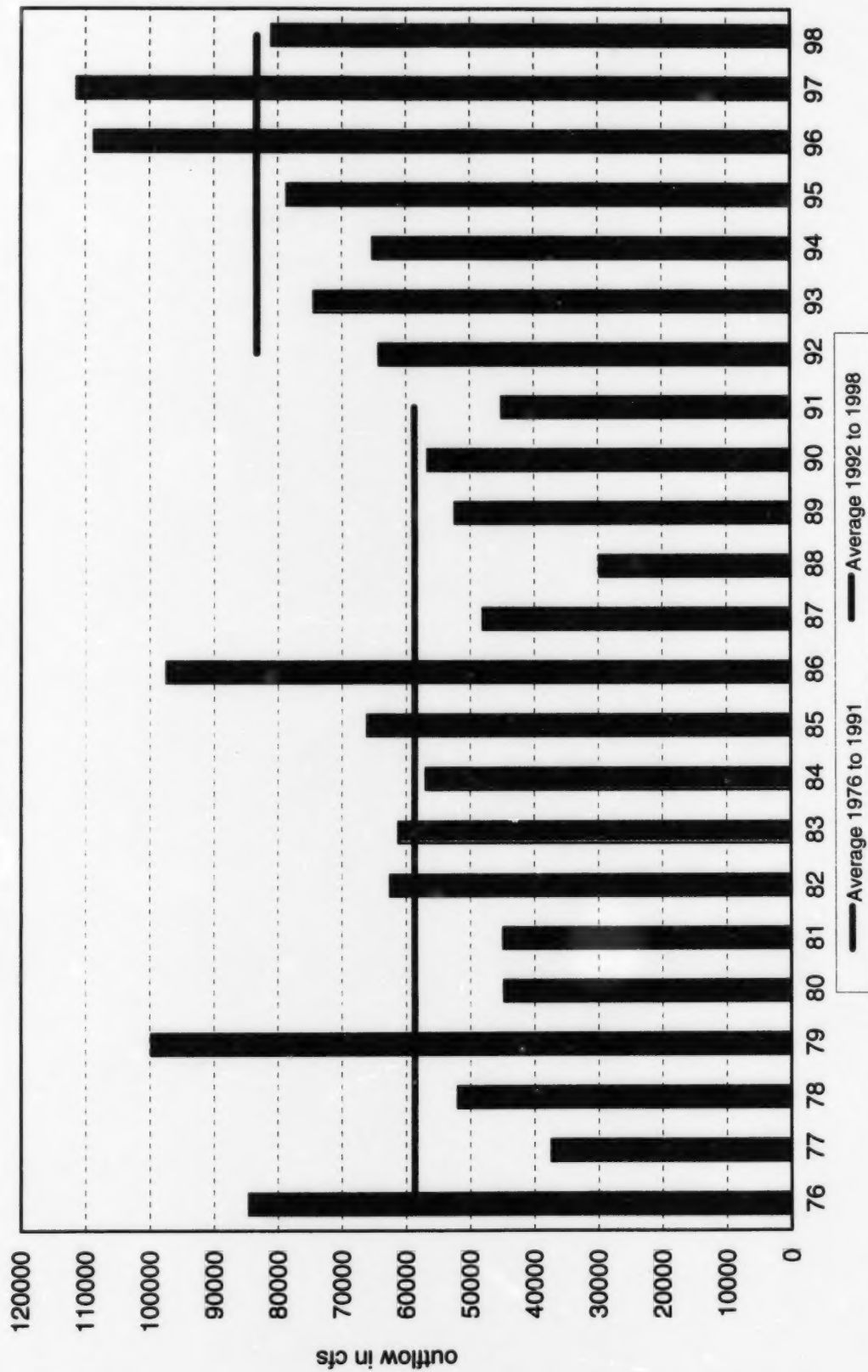


Figure 5

Lake Winnipeg Average Outflow - Winter

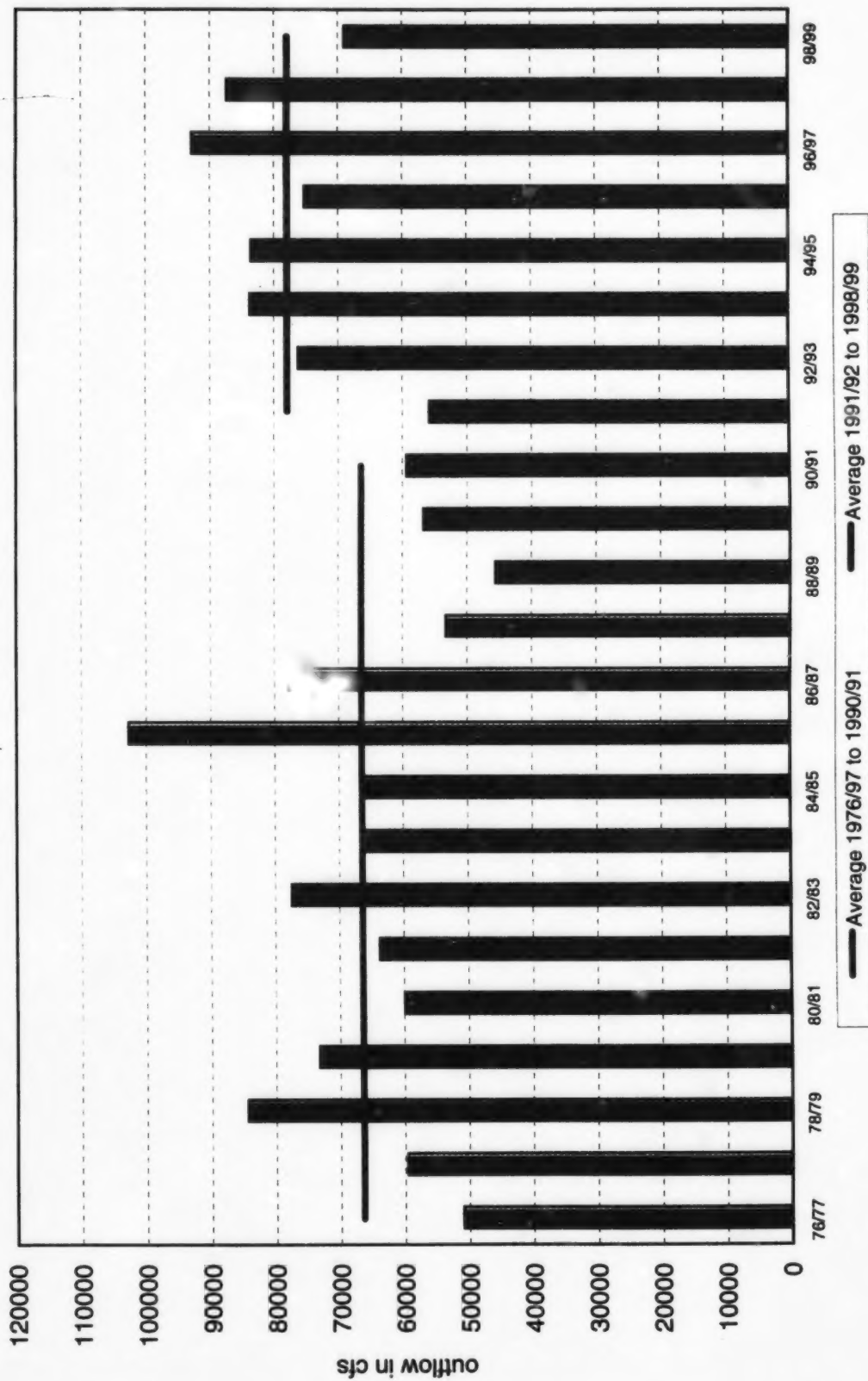
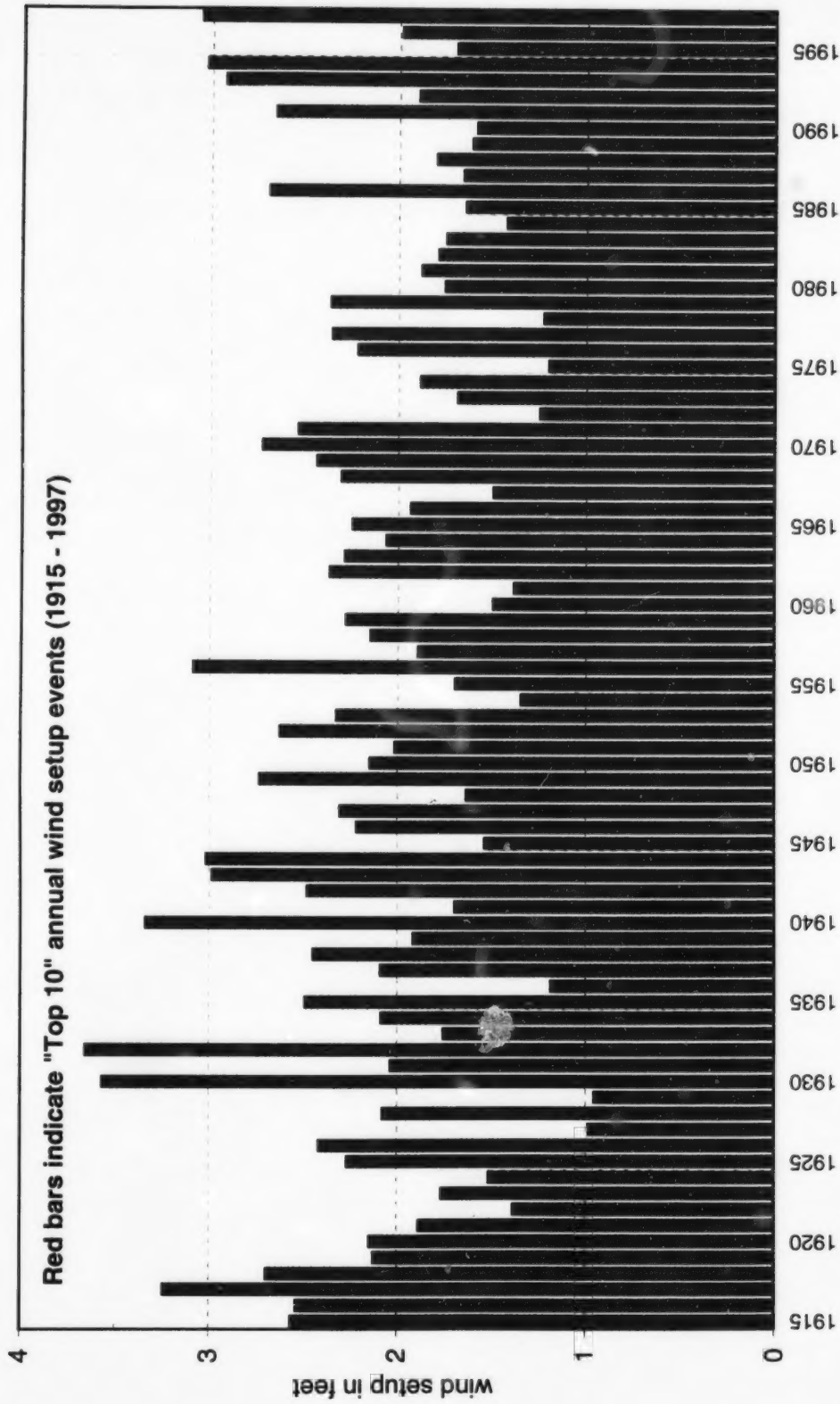


Figure 6

Maximum Annual Wind Setup Events Winnipeg Beach/Gimli



Revised: January 13, 2000

Data from 1915 to 1997
(based on WSC published data)

Figure 7

Maximum Wind Setup Events Winnipeg Beach/Gimli

Rank	Date	Setup (Feet)	Wind Eliminated Elevation (Feet)
1	November 11, 1932	3.7	710.8
2	October 18, 1930	3.6	710.7
3	November 12, 1940	3.3	709.8
4	July 2, 1917	3.2	714.6
5	October 8, 1956	3.1	715.0
6	November 2, 1997	3.1	714.4
7	October 24, 1994	3.0	713.5
8	August 31, 1944	3.0	713.7
9	October 14, 1943	3.0	714.0
10	October 29, 1993	2.8	714.5

Table 1

2000 05 02

Lake Winnipeg Shoreline Erosion Advisory Group

Attention: Mr. Dave Farlinger, P.Eng.

#1 - 117 Victor Lewis Drive

Winnipeg, Manitoba

R3P 1J6

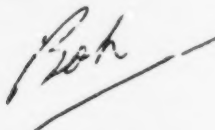
Dear Mr.  Farlinger:**Re: Lake Winnipeg Shoreline Erosion Advisory Group (LWAG) Questions**

Attached are clarifying responses to questions 1e and 3 of your February 10, 2000 letter requesting information on Lake Winnipeg.

We believe that the response provided for question 3 will more than adequately clarify your understanding of the value of our operating range and does not require further explanation from Manitoba Hydro staff.

Thank you for the recently provided reports finalized by LWAG. We look forward to the forthcoming report on practical shoreline protection options and the LWAG final report. I understand that LWAG expects to complete its mandate in June 2000.

Yours truly,



RBB/sk

Att.

- c: Mr. N.B. Brandson, Deputy Minister, Dept. of Conservation
Mr. O. Boulette, Deputy Minister, Dept. of Aboriginal and Northern Affairs

Attachment

Question 1e)

Would a lower lake level influence erosion? What would the effects be over time?

Wind and wave energy are the primary drivers of erosion. Water level is only one of the many secondary factors that can influence erosion, including soil type, exposure, shore slope, vegetation, man-made structures, and soil saturation above the water-line, among others.

Manitoba Hydro has not carried out studies to determine the relative impact of lower water levels on erosion. Therefore, we cannot comment on how lower water levels, if they were achievable, would effect erosion over time.

Question 3

Hydro has expressed concern over the prospect of any change in regulated levels of Lake Winnipeg, indicating that any reduction on the upper limit would cost Manitobans huge amounts of money. What are the details of these costs and how are they arrived at?

The water elevation on Lake Winnipeg does not directly affect the generation at the large lower Nelson River generating plants (Kettle, Long Spruce and Limestone). These plants, which account for approximately 70% of Manitoba Hydro's generating capacity, depend on river flows released from Lake Winnipeg at the Jenpeg Generating Station and Control Structure. Judicious operation of Lake Winnipeg Regulation over the full range of the power production zone (711 to 715 feet) enables Manitoba Hydro to provide reliable and sufficient flows to the Nelson River plants under all inflow conditions. Reducing the upper end of this range from 715 to 714 feet would reduce the usefulness of and the benefits gained from Lake Winnipeg Regulation.

The majority of the benefit from using the 1 foot range between 714 and 715 feet is derived from increased dependable energy (firm energy corresponding to the lowest inflows on record). Increased dependable energy means that Manitoba Hydro will be able to delay the installation of new generating resources and/or secure higher valued long-term export sales. A secondary component of the benefit comes from increased operating flexibility. Increased operating flexibility improves the ability to manage outflows as required to meet power demands.

To estimate this generation benefit, Manitoba Hydro uses a computer based model to simulate the operation of the total integrated system under both the base 711 to 715 feet range and the reduced 711 to 714 feet range. The benefit is the difference in the present value of the capital costs, system operating costs and net export revenue under the two scenarios.

In addition to impacts on generation, reducing the upper end of the power production range from 715 to 714 feet, would increase the frequency and duration of maximum discharge periods at Jenpeg. This would increase flooding impacts on downstream communities and would require revisiting NFA implementation and other compensation agreements.

The total cost associated with losing the upper one-foot of the range was estimated in 1997 to be approximately \$300 million. This estimated cost to Manitoba power consumers includes system development and operating costs as well as costs to mitigate flooding impacts on downstream communities. Since energy values have been rising over the past few years, this is more likely to be an underestimate than an overestimate.